Cornell University Library

BOUGHT WITH THE INCOME
FROM THE
SAGE ENDOWMENT FUND
THE GIFT OF
Henry W. Sage
1891

A.163560 15/11/1902

1245

Cornell University Library
QM 34.H89
v.3
Manual of practical anatomy,
3 1924 024 788 667
olin

DATE DUE

~~MAY 13 1976 GP~~			
GAYLORD			PRINTED IN U.S.A.

QH
34
H89
v.3

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924024788667

A MANUAL
OF
PRACTICAL ANATOMY

HUGHES' ANATOMY

PART I
THE UPPER AND LOWER EXTREMITIES

PART II
THE ABDOMEN AND THORAX

PART III
THE HEAD, NECK, AND CENTRAL NERVOUS SYSTEM

A MANUAL
OF
PRACTICAL ANATOMY

BY THE LATE

PROFESSOR ALFRED W. HUGHES, M.B., M.C. EDIN.
F.R.C.S. EDIN.; F.R.C.S. ENG.

PROFESSOR OF ANATOMY, KING'S COLLEGE, LONDON
EXAMINER IN ANATOMY, ROYAL COLLEGE OF SURGEONS, ENGLAND
EXAMINER IN ANATOMY, UNIVERSITY COLLEGE OF SOUTH WALES

EDITED AND COMPLETED BY

ARTHUR KEITH, M.D. ABERD.; F.R.C.S. ENG.

LECTURER ON ANATOMY, LONDON HOSPITAL MEDICAL COLLEGE
FORMERLY HUNTERIAN PROFESSOR, ROYAL COLLEGE OF SURGEONS, ENGLAND

IN THREE PARTS

PART III

THE HEAD, NECK, AND CENTRAL NERVOUS SYSTEM

Illustrated by 12 Coloured Plates and 204 Figures in the Text

LONDON
J. & A. CHURCHILL
7 GREAT MARLBOROUGH STREET
1902

15/11/02

9706F75

A.163560

JT

EDITOR'S NOTE

THE labour of preparing this work for the press has been lightened by the memory of its genial and able author, and the goodwill of his numerous friends. The services of Mr. J. H. Watson and Mr. Robert Milne of the London Hospital, in removing obscurities and inaccuracies from the text, have rendered the Editor's task much easier. In the preparation of over one hundred and sixty illustrations for the text, the Editor gratefully acknowledges the valuable assistance of Mr. F. W. JONES, Dr. BALEAN, Mr. ALFRED BILLINGHURST, Dr. K. F. LUND, and Mr. W. R. M. TURTLE.

Many of the figures used in illustrating the text have been borrowed, with full acknowledgments, from other anatomical works issued by Messrs. J. & A. Churchill. Of these must be mentioned Wilson's 'Anatomist's Vade-Mecum,' Heath's 'Practical Anatomy,' and 'A Treatise of Human Anatomy,' edited by Morris. The authorship of fig. 201, Part II., showing the pelvic fascia in vertical section, should have been ascribed to Heath, not to Wilson.

Of the fifty-four coloured plates, which form a special feature of this work, thirty were prepared under the direction of Professor Hughes by Mr. Prendergast Parker, four are from the classical work of Maclise, while the remaining twenty are osteological plates, prepared under the supervision of Professor H. E. Clark, C.M.G., for Wilson's 'Anatomist's Vade-Mecum.' By an oversight, for which the Editor is responsible, the authorship of these plates is ascribed in Part I. of this work to Mr. Holden.

March 1902.

CONTENTS

OF

THE THIRD PART

HEAD AND NECK

DISSECTION PAGE

I. THE DORSAL REGION OF THE HEAD AND NECK . 1

II. THE MUSCLES OF THE SPINE 23

III. THE DIVISIONS AND SUPERFICIAL STRUCTURES ON THE ANTERO-LATERAL ASPECT OF THE NECK . . 34

IV. THE POSTERIOR TRIANGLE OF THE NECK . 47

V. THE ANTERIOR TRIANGLE OF THE NECK . . 54

VI. THE STERNO-MASTOID AND STRUCTURES BENEATH IT . 69

VII. DISSECTION OF THE SCALP, EXPOSURE AND REMOVAL OF THE BRAIN 91

VIII. STRUCTURES SEEN IN THE BASE OF THE SKULL AFTER THE REMOVAL OF THE BRAIN . 114

IX. THE DISSECTION OF THE FACE . 126

X. THE ORBIT AND ITS CONTENTS . . . 141

XI. THE PAROTID SPACE . . . 173

XII. THE MUSCLES OF MASTICATION 178

XIII. THE SUBPAROTID REGION 194

XIV. THE SUBMAXILLARY TRIANGLE AND SPACE . 203

DISSECTION PAGE
XV. THE SUBLINGUAL SPACE . . 211
XVI. THE TONGUE 213
XVII. THE PREVERTEBRAL AND RETRO-PHARYNGEAL REGIONS 221
XVIII. THE PHARYNX AND MOUTH 232
XIX. THE LARYNX 249
XX. THE NASAL CAVITIES 259
XXI. THE EAR AND PETRO-MASTOID REGION 270
XXII. THE SPINAL CORD 289
XXIII. THE BRAIN 303

INDEX 379

ILLUSTRATIONS

TO

THE THIRD PART

PLATES

PLATE			
XLIII.	The Relationships of the Outer and Inner Aspects of the Occipital Bone. (*H. E. Clark*) . .	*to face p.*	10
XLIV.	The Relationships of the Outer and Inner Aspects of the Temporal Bone. (*H. E. Clark*) . . .	,,	14
XLV.	A Diagrammatic Section of the Neck to show the arrangement of the Deep Cervical Fascia. (*Hughes*)	,,	41
XLVI.	Deep Dissection of Head and Neck. (*Maclise*) .	,,	70
XLVII.	The Outer and Inner Aspects of the Frontal Bone. (*H. E. Clark*)	,,	98
XLVIII.	A Mesial Vertical Section of the Head and Neck (*Hughes*)	,,	108
XLIX.	Base of the Skull after removal of the Brain. The Venous Sinuses and Intra-cranial Stages of the Cranial Nerves are shown. (*Hughes*) . .	,,	110
L.	The Outer and Inner Aspects of the Superior Maxillary Bone. (*H. E. Clark*)	,,	130
LI.	Two Aspects of the Sphenoid with the Muscular Attachments to Each. (*H. E. Clark*) .	,,	152
LII.	The Muscular Attachments to the Lower Jaw. (*H. E. Clark*)	,,	180
LIII.	Vertical Mesial Section of the Head and Neck, to show the Nasal, Buccal, and Pharyngeal Cavities and Exit of the Cranial Nerves. (*Hughes*) .	,,	244
LIV.	View of the Base of the Brain. (*After Beaunis*)	,,	314

IN TEXT

FIG. PAGE

266. A transverse Section at the Level of the Fifth Cervical Vertebra, showing the Layers of Structures encountered in the Dissection of the Dorsal Region of the Neck. Only the Fascial Sheaths are shown on the left side of the section. (*Editor*) 2

267. The Superficial Structures on the Dorsal Aspect of the Head and Neck. (*F. W. Jones*) 5

268. The Origin and Distribution of the Posterior Division of a Spinal Nerve. (*Balean*) 6

269. The Boundaries and Floor of the Posterior Triangle of the Neck. (*Editor*) 9

270. Nerves in the Posterior Triangle of the Neck. (*After Hirschfeld and Leveillé, from Morris's 'Anatomy'*) 11

271. Diagram of the Origin and Course of the Supra-scapular and Transverse Cervical Arteries as viewed from above the right shoulder. (*Editor*) 13

272. The Splenius, Complexus, and Vertebral Aponeurosis. (*From Morris's 'Anatomy'*) 16

273. The Boundaries and Contents of the Suboccipital Triangle. (*F. W. Jones*) 20

274. The Anterior, Middle, and Posterior Layers of the Lumbar Aponeurosis. (*Editor*) 25

275. The Erector Spinæ and its Prolongations in the Neck. The Outer and Middle Columns are separated. (*From Morris's 'Anatomy'*) 26

276. A Rib and Vertebra showing the attachment of the Erector Spinæ. (*F. W. Jones*) 27

277. The Multifidus Spinæ and Semispinalis. (*From Morris's 'Anatomy'*) 29

278. The Nerves of the Back. (*From Hirschfeld and Leveillé*). . 31

279. The Origin and Distribution of the Posterior Branch of an Intercostal Artery. (*Editor*) 32

280. The Triangles and Spaces into which each side of the Neck is divided. (*Editor*) 35

281. The Superficial Veins of the Head and Neck. (*Quain*) . . . 40

282. A Section of the Neck to show the parts of the Deep Cervical Fascia. (*Editor*) 42

283. Diagram of the Layers of the Deep Cervical Fascia in an Antero-posterior Section opposite to the Sternum. (*Tillaux*) . . 44

FIG. PAGE
284. The Deep Cervical Lymphatic Glands (from a preparation in which the Glands were enlarged from Disease). (*F. W. Jones*) 45
285. The Boundaries and chief Contents of the Subclavian Triangle. (*From a preparation by H. F. Warner*) 47
286. The Floor of the Subclavian Triangle and Cervico-axillary Passage. (*Editor*) 51
287. The Brachial Plexus. (*From Morris's 'Anatomy'*) . . 52
288. The Boundaries and Muscles in the Roof of the two inferior Carotid Triangles. (*Editor*) 55
289. The Chief Contents of the Inferior Carotid Triangles. (*Editor*) . 58
290. Section of the Neck showing the relative position of the Main Contents of the Inferior Carotid Triangles. (*Editor*) . . 59
291. The Boundaries and Chief Contents of the Superior Carotid Triangle. (*Editor*) 61
292. The Nerves and Muscles on the Floor of the Superior Carotid Triangle. (*Editor*) 64
293. Cranial and Cervical Nerves. (*Hirschfeld and Leveillé*) . . 66
294. The Nerves beneath the Sterno-mastoid. (*Hirschfeld and Leveillé*) 71
295. Diagram of the Cervical Plexus. (*From Morris's 'Anatomy'*) . 74
296. Diagram of the Nerves entering into the formation of the Cardiac Plexuses. (*Clark*) 77
297. Diagram of the Cervical Sympathetic Cord and Ganglia. (*Heath*) 79
298. The Cervical Stage of the Thoracic Duct. The Clavicle, Sterno-mastoid, and Internal Jugular Vein have been removed to expose it. (*F. W. Jones*) 80
299. Vertical section at the junction of the Neck and Thorax to show the relationship of Sibson's Fascia (Apical Fibrous Dome) to the Subclavian Vessels and Inferior Trunk of the Brachial Plexus. (*Editor*) 83
300. Diagram of the Stages and Branches of the Right Subclavian Artery. (*F. W. Jones*) 88
301. The Boundaries of the Vertebral Triangle and its Contents. (*Editor*) 89
302. The Chief Surface Markings of the Head. (*F. W. Jones*) . . 92
303. A Section of the Scalp, Sagittal Suture, Longitudinal Sinus, Falx Cerebri, and Meninges. (*Editor*) (*Diagrammatic*) . . . 95
304. The Vessels and Nerves of the Frontal Segments of the Scalp. (*Editor*) 97
305. The Arteries of the Scalp and Face. (*After Merkel*) . . . 100
306. Structures in the Temporal Fossa divided in exposing the Temporal Lobe. (*Editor*) 101

FIG. PAGE
307. Veins and Lymphatic Glands of the Scalp and Face. (*F. W. Jones*) . . . 102
308. External view of the Left Auricle. (*From Morris's 'Anatomy'*) 104
309. The Pinna and its Muscles. (*From Wilson, after Arnold*) . 105
310. The Pinna and its Muscles as seen from behind. (*Wilson, after Arnold*) . . . 106
311. The Nerves and Arteries of the External Ear and Meatus. (*Editor*) . . . 107
312. A Diagram of the Structures within the Foramen Magnum. (*Editor*) . . . 112
313. A Diagram of the Sinuses on the Base of the Skull. (*Wilson*) . 115
314. The Intracranial Venous Sinuses. (*F. W. Jones*) . . . 116
315. The External Table of the Skull removed to show the Veins of the Cranial Diploë. (*Wagstaffe*) . . . 117
316. The Oculo-motor Triangle and the Passage in the Tentorium Cerebelli occupied by the Crura Cerebri. (*Editor*) . . 118
317. Transverse Vertical Section of the Body of the Sphenoid, Pituitary Body, and Cavernous Sinuses. (*Editor*) (*Diagrammatic*) . 119
318. The Course and Divisions of the Middle Meningeal Artery. (*F. W. Jones*) . . . 120
319. Vertical Mesial Section to show: (1) the two parts of the Pituitary Body; (2) the Third Ventricle; (3) the Cisterna Basalis; (4) the Sphenoidal Sinus. (*Editor*) . . . 125
320. Section of the Lips. (*Editor*) (*Semi-diagrammatic*) . . . 127
321. The Superficial Muscles of the Head and Neck. (*From Morris's 'Anatomy'*) . . . 128
322. The Deeper Layer of the Muscles of the Face and Neck. (*From Morris's 'Anatomy'*) . . . 130
323. Muscles of the Nose. (*Wilson*) . . 132
324. The Cartilages and Bones of the Nose viewed from the side. (*Arnold*) . . . 133
325. The Cartilages of the Nose viewed from the front. (*Wilson*) . 133
326. Nerves of the Face and Scalp. (*Hirschfeld and Leveillé*) . . 135
327. The Course and Branches of the Facial Artery. (*F. W. Jones*) . 137
328. The Lachrymal Apparatus and Nasal Duct. (*Bellamy*) . . . 141
329. Appendages of the Eye. (*Wilson*) . . . 142
330. Section of the Orbit and Eye to show Tenon's Capsule and Space and the Chambers of the Eye. (*Editor*) (*Diagrammatic*) . . 143
331. Section of Upper Eyelid. (*After Merkel*) . . . 144
332. Meibomian Glands, as seen upon the inner aspect of the Eyelids. (*Arnold*) . . . 145

FIG. PAGE

333. View of Eyeball &c. obtained on drawing the Lids forcibly apart. (*After Merkel, from Morris's 'Anatomy'*) 147

334. Section of the Lachrymal Sac to show its relationship to the Internal Tarsal Ligament and Tensor Tarsi. (*Editor*) . . 148

335. Superficial Dissection of the Nerves of the Orbit. (*Hirschfeld and Leveillé*) 150

336. Diagram of the Ophthalmic Veins, Cavernous Sinus, and the Nerves in the Wall of the Sinus. (*F. W. Jones*) 151

337. Horizontal Section through Left Orbit, viewed from above. (*After Von Gerlach, from Morris's 'Anatomy'*) 153

338. Distribution of the Ophthalmic Artery. (*Merkel and Henle*) . 154

339. Arteries of the Orbit from the Outer Side. (*From Hirschfeld and Leveillé*) 156

340. Arteries and Veins of the Orbit. (*From Hirschfeld and Leveillé*) 157

341. Dissection of the Eyeball, showing its Second Tunic, and the mode of Origin of the Venæ Vorticosæ of the Choroid. (*Arnold*) 158

342. Nerves of the Orbit, seen from the Outer Side. (*From Hirschfeld and Leveillé*) 159

342A. Diagram of the Lenticular Ganglion. (*From Hirschfeld and Leveillé*) 159

343. Muscles of the Eyeball. The view is taken from the Outer Side of the Right Orbit. (*Wilson*) 160

344. Diagrammatic view of the Insertions of the Ocular Muscles. (*After Merkel*) 161

345. Diagrammatic representation of Origins of Ocular Muscles at the Apex of the Right Orbit. (*After Schwalbe, from Morris's 'Anatomy'*) 162

346. Dissection of the Superior Maxillary Nerve and Meckel's Ganglion. (*From Hirschfeld and Leveillé*) 163

347. Semi-diagrammatic Horizontal Section through Eyeball and Optic Nerve. (*After Elfinger, from Morris's 'Anatomy'*) . 165

348. Fundus of the Eye and Optic Disc. (*After Jaeger*) . . . 167

349. Vertical Section of the Coats of the Eye at the point of entrance of the Optic Nerve. (*Ecker*) 168

350. Diagrammatic Section of the Eye. (*Allen Thomson*) . . 169

351. Scheme of Circulation of the Eye. (*After Leber*) 170

352. Equatorial Section of Eyeball: Anterior Segment viewed from behind. (*After Merkel*) 171

353. Section of the Corneo-scleral Junction, showing the Ciliary Muscle. (*After Jevans*) 171

354. The Crystalline Lens. (*Babuchin*) 173

355. The Parotid Gland and Structures over the Masseter. (*Editor*) 174

FIG. PAGE

356. A Section to show the Contents of the Parotid Space. (*F. W. Jones*) 175

357. The Structures beneath the Parotid Gland. (*Editor*) . . . 177

358. A Dissection to show the Boundaries and Floor of the Zygomatic Space. (*Editor*) 181

359. The External and Internal Pterygoid Muscles. (*Wilson*) . . 182

360. The External Lateral Ligament of the Temporo-maxillary Articulation. (*Wilson*) 183

361. The Long Internal Lateral or Spheno-Mandibular Ligament of the Temporo-maxillary Articulation. (*Wilson*) 183

362. Section of the Temporo-maxillary Articulation to show the Meniscus. (*Wilson*) 184

363. The Passage between the Parotid and Zygomatic Spaces with the Structures passing through it. Viewed from behind. (*Editor*) 185

364. The Stages and Branches of the Internal Maxillary. (*W. R. M. Turtle*) 187

365. The Nerves of the Zygomatic Space. (*Hirschfeld and Leveillé*) 189

366. The Third Division of the Fifth and the Otic Ganglion viewed on their Deep Surfaces. (*Hirschfeld and Leveillé*) 191

367. The Muscles of the Pharynx, especially those beneath the Internal Pterygoid. (*Sappey*) 193

368. A Section at the Upper Border of the Axis to show the Contents and Boundaries of the Subparotid Space. (*Editor*) . . . 195

369. The Boundaries and Chief Contents of the Subparotid Space. (*Editor*) 196

370. The Vessels and Nerves of the Subparotid Space. (*Hirschfeld and Leveillé*) 198

371. Diagram of the Ninth, Tenth, Eleventh, Twelfth Cranial, and Sympathetic Nerves in the Subparotid Space and Superior Carotid Triangle. (*Hirschfeld and Leveillé*) 199

372. Diagram of the Superior Cervical Ganglion and its Connections. (*Heath*) 201

373. The Boundaries and Floor of the Submaxillary Space. (*Editor*) 203

374. Styloid Muscles and Muscles of the Tongue. (*Wilson*) . . 205

375. The Nerves of the Tongue and Submaxillary Space. (*Hirschfeld and Leveillé*) 209

376. Structures beneath the Mucous Membrane of the Floor of the Mouth. (*Alfred Billinghurst*) 210

377. Section of the Floor of the Mouth and Tongue to show the Contents of the Sublingual Space. (*Editor*) 211

378. The Contents of the Sublingual Space. (*Editor*) 212

379. The Dorsal Aspect of the Tongue. (*Hirschfeld and Leveillé*) . 214

FIG. PAGE
380. The Under Surface of the Tongue. (*Modified from Merkel*) . . 215
381. The Course and Branches of the Lingual Artery. (*Hirschfeld and Leveillé*) 217
382. Extrinsic and Intrinsic Muscles of the Tongue. (*Kölliker*) . . 220
383. The Prevertebral Group of Muscles of the Neck. (*Wilson*) . 222
384. The four Stages in the Course of the Vertebral Artery. (*Editor*) 225
385. Posterior Ligaments of the Occipito-atlantal and Atlanto-axial Articulations. (*Wilson*) 227
386. Vertical Sagittal Section of the Occipital Bone, Atlas and Axis, showing the Ligaments which bind them together in this Plane. (*Editor*) 228
387 Upper part of the Vertebral Canal, opened from behind in order to show the Posterior Occipito-axial Ligament. (*Wilson*) . . 229
388. Vertical Transverse Section of the Spinal Column and the Occipital Bone to show the Ligaments between the Axis, Atlas, and Occipital Bone. (*From Morris's 'Anatomy'*) . . . 230
389. Anterior View of the Ligaments connecting the Atlas, Axis, and Occipital Bone. (*From Wilson*) 231
390. A Vertical Sagittal Section of the Pharynx to show its three Divisions and the Structures seen in each. (*Editor*) . . 233
391. Dissection of the Constrictor Muscles of the Pharynx, with the Vessels and Nerves in relation with them. (*Heath*) . . . 234
392. A Diagram of the Boundaries and Structures within the Sinus of Morgagni. (*Editor*) 236
393. Pharynx laid open from behind. (*Sappey*) . . 237
394. The Posterior Wall of the Pharynx. (*Luschka*) . . . 238
395. Vertical Section of the Tonsil. (*H. E. Clark*) 239
396. View of Muscles of Soft Palate as seen from within the Pharynx. (*From Morris's 'Anatomy'*) 241
397. The Eustachian Cartilage, Tensor Palati, and Levator Palati Muscles. (*K. F. Lund*) 243
398. Vertical Section of Molar Tooth. (*Carpenter*) 247
399. Front and Side View of a Left Upper Central Incisor. (*Tomes*) 248
400. Lingual, Labial, and Distal Surfaces of an Upper Canine. (*Tomes*) 248
401. Front View of the Cartilages of the Larynx. (*Modified by Hensman, from Bourgery and Jacob*) 250
402. Nerves of the Larynx. (Posterior View.) (*From Morris's 'Anatomy'*) 252
403. The Articulation and Connections of the Right Arytenoid Cartilage. (*Editor*) 253
404. The Muscles of the Larynx viewed from behind (*Sappey*) . 254

FIG. PAGE

405. The Muscles of the Larynx viewed on removal of the greater part of the right half of the Thyroid Cartilage. The lower part of the Cartilage is thrown down. (*Sappey*) 255

406. Laryngoscopic view of the Larynx from above during the Emission of a High Note. (*Czermak*) 256

407. Vertical Section of Larynx showing its Interior. (*Sappey*) 257

408. Olfactory Nerves, with their Distribution on the Septum Nasi. (*Wilson*) 260

409. The Bones and Arteries of the Lateral Wall of the Right Nasal Cavity and of the Palate. (*Editor*) 262

410. The Lateral Wall of the Right Nasal Cavity. (*K. F. Lund*) . 263

411. Outer Wall of Nasal Cavity and Naso-pharynx. (*Anderson, after Merkel*) 265

412. Meckel's Ganglion and its Branches. (*From Hirschfeld and Leveillé*) 267

413. Diagram to show (1) the Spheno-Maxillary Fossa and the Nerves contained in it; (2) the Petrosal Nerves; (3) the Inner Wall of the Tympanum; (4) the Intra-cranial Course of the Internal Carotid Artery. (*Editor*) 268

414. Transverse Vertical Section of the Right External Auditory Meatus, Tympanum, Vestibule, and Internal Auditory Meatus, looking from before backwards. (*Editor*) . . . 271

415. The Anterior Half of the Section shown in fig. 414, looking from behind forwards. (*Editor*) 273

416. Section of the Ear passing from behind forwards and inwards, and exposing the Antrum of the Mastoid and Eustachian Tube. (*Politzer*) 275

417. Outer Wall of the Tympanum. (*From Heath's 'Anatomy'*) . . 277

418. The Ossicula Auditus. (*Wilson*) 279

419. Profile view of the Left Tympanic Cavity, Membrane and Ossicles. (*E. A. Schaefer*) 280

420. External view of the Left Membrana Tympani. (*Enlarged, from life, from Morris's 'Anatomy'*) . . . 282

421. The Inner Wall of the Tympanum. (*After Poirier* . 283

422. Interior of the Osseous Labyrinth of the Left Side. *Hensman, after Sœmmerring. Enlarged*) 286

423. Enlarged diagrammatic view of Membranous Labyrinth. (*From Morris's 'Anatomy'*) 287

424. Scheme of Auditory Apparatus. (*After Poirier*) 288

425. Section across the Cervical Part of the Spinal Cord and its Membranes. (*Editor*) (*Semi-diagrammatic*) 290

426. View of the Membranes of the Spinal Cord. (*Ellis*) . . . 293

FIG. PAGE
427. The Cauda Equina, seen from behind. (*From Hirschfeld and Leveillé*) 295
428. Fourth Ventricle and upper part of Spinal Cord and Membranes. The Posterior Roots of the Nerves are removed on the left side. (*Hirschfeld and Leveillé*) 296
429. Vertebral and Spinal Veins. A. Horizontal View. B. Vertical View. (*Breschet*) 297
430. Diagram of the Tracts of the Spinal Cord. (*Gowers*) . . 300
431. Sections through different Regions of the Spinal Cord. (*After Schwalbe, from Morris's 'Anatomy'*) 302
432. Vertical Mesial Section of the Brain, to show (1) its Main Divisions, (2) the Arrangement of Arachnoid, and (3) the Third and Fourth Ventricles. (*Editor*) 303
433. A Section of the Structures covering the Brain. (*Editor*) . . 305
434. The Arteries on the Base of the Brain, with the Origin of the Cranial Nerves and Arrangement of Arachnoid. (*Editor*) . 307
435. Circle of Willis. (*Wilson*) 309
436. The Cortical Distribution of the three Cerebral Arteries on the External Surface of the Cerebral Hemisphere. (*From Heath*) 310
437. The Cortical Distribution of the three Cerebral Arteries on the Mesial and Tentorial Aspects of the Cerebral Hemisphere. (*From Heath*) 311
438. Floor of Fourth Ventricle, showing Nuclei of Origin of Cranial Nerves. (*Erb*) 314
439. Surface Origin of the Cranial Nerves. (*After Allen Thomson. Quain*). 317
440. The Central or Sensori-motor Region of the Cerebrum. (*Editor*) 319
441. The Island of Reil exposed. (*Alfred Billinghurst*) . . . 322
442. Lateral view of the Convolutions of the Brain. (*Anderson, after Thane, in Heath's 'Anatomy'*) 324
443. The Inner and Tentorial Surfaces of a Cerebral Hemisphere, showing the Convolutions and Sulci. (*Anderson, after Thane, in Heath's 'Anatomy'*) 325
444. Orbital Surface of the Frontal Lobe, and Island of Reil. (*Anderson, after Turner*) 329
445. Mesial Section of entire Brain. (*After Henle*) 333
446. A Vertical Coronal Section of the Basal Ganglia, Lateral and Third Ventricles. (*Editor, after Schaefer*) 336
447. A Dissection of the White Matter of the Posterior Part of the Right Cerebral Hemisphere. (Viewed from the inner side.) (*Schwalbe*) 339
448. Lateral Ventricles of the Brain. (*From Hirschfeld and Leveillé*) 340

FIG. PAGE
449. Metencephalon, Mesencephalon, and Thalamencephalon, from the Dorsal Surface. (*After Obersteiner*) 342
450. The Velum Interpositum, from above. (*Editor*) (*Semi-diagrammatic*) 343
451. The Descending and Posterior Cornua of the Lateral Ventricles. (*Hirschfeld and Leveillé*) 345
452. A Section through the Structures in the Floor of the Descending Horn. (*Hirschfeld and Leveillé*) 346
453. The Vestigial Gyri of the Rhinencephalon, the Choroidal Fissure, Fornix, and Corpus Callosum. (*Editor*) 348
454. Coronal Section of the Brain through the Third Ventricle and Basal Ganglia behind the Middle Commissure. (*Gegenbaur*) . 353
455. Horizontal Section of the Cerebrum. (*After Landois and Stirling*) 354
456. Lateral view of Mesencephalon, Pons, and Medulla. (*Gegenbaur*) 358
457. Transverse Section of the Mesencephalon. (*Wernicke and Gowers*) 359
458. Right half of the Encephalic Peduncle as seen from the inside of a Median Section. (*Allen Thomson, after Reichert*) . . 363
459. The Floor of the Fourth Ventricle. (*Erb*) 364
460. The Peduncles of the Cerebellum. (*Hirschfeld and Leveillé*) . 365
461. The Lobes of the Cerebellum. (*Editor, after Schaefer*) A. Those on the Upper Surface; B. Those on the Lower Surface. . . 367
462. The Constituents of the Cortex of the Cerebellum. (*Meynert*) . 369
463. Diagram of the Floor of the Fourth Ventricle. (*Schaefer*) . . 370
464. Transverse Section through the Upper Part of the Pons. (*Schwalbe*) 371
465. Front view of the Upper Part of the Spinal Cord, Medulla, and Pons. (*Ecker*) 373
466. Dorsal view of the Medulla with the Cerebellum pulled forwards to expose the Inferior Medullary Velum. (*Editor*) (*Semi-diagrammatic*) 374
467. Section of Medulla about the Middle of Olivary Body. (*Schwalbe*) 375
468. Transverse Section of the Medulla in the Region of the Decussatio Lemnisci. (*Schwalbe*) 376

MANUAL OF PRACTICAL ANATOMY

PART III

THE HEAD AND NECK

DISSECTION I

THE DORSAL REGION OF THE HEAD AND NECK

For the first three days at least the body lies on its face; during this time the dissectors of the head have to examine all the structures which lie on the dorsal aspect of the cervical region of the spine and occipital region of the skull. A large number of muscles are found in this dissection. Most of these extend or rotate the head on the spine; others which lie deeper extend or rotate the cervical region of the spine, while the more superficial act on the upper extremities.

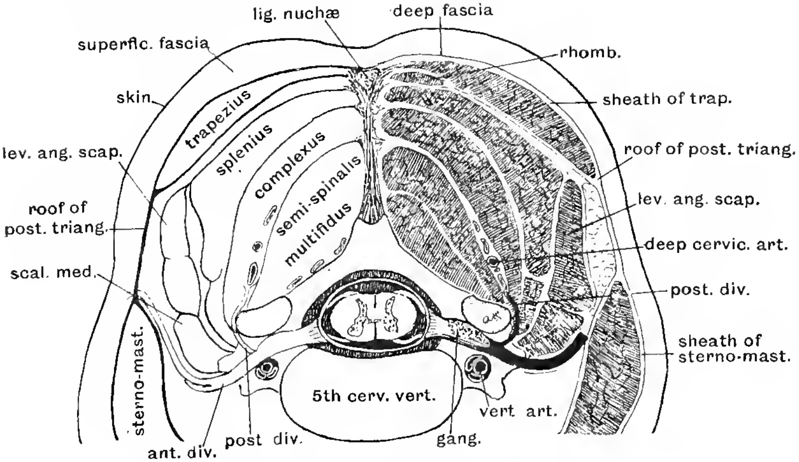
The actual boundary between the dissections of the head and neck and the upper extremity, on the posterior aspect of the body, is a line drawn from the seventh cervical spine—the first prominent spinous process—to the outer end of the clavicle. But so many structures rise in their part and pass to the upper extremity that, in dissecting these out, it is necessary for the dissectors of the head and neck to work in common with the junior men working on the upper extremity. Such an arrangement is advantageous to the dissectors of both parts.

Position of the Subject.—The breast is raised high on blocks, so that the head hangs downwards and the extensor muscles of the neck are rendered tense.

Surface Markings.—(1) The *external occipital protuberance* (Plate XLIII). It marks the termination of the superior longitudinal sinus and the commencement of the right and left lateral sinuses within the attachment of the tentorium cerebelli. The occipital lobes lie above it; the cerebellum is situate below it.

(2) The *nuchal furrow.*—The median furrow of the neck is bounded on each side by a rounded mass, formed by the extensor muscles of the head. The furrow commences below the external occipital protuberance and ends at the seventh cervical spine. The ligamentum nuchæ stretches between these two points beneath the floor of the furrow.

FIG. 266.—A TRANSVERSE SECTION AT THE LEVEL OF THE FIFTH CERVICAL VERTEBRA, SHOWING THE LAYERS OF STRUCTURES ENCOUNTERED IN THE DISSECTION OF THE DORSAL REGION OF THE NECK. ONLY THE FASCIAL SHEATHS ARE SHOWN ON THE LEFT SIDE OF THE SECTION.



(3) The *spine of the seventh cervical vertebra.*—It is the first prominent spine. The sixth occasionally projects nearly as much as the seventh.

(4) The *superior curved lines* (Plate XLIII, p. 10). They form the upper limit of the attachment of muscles to the occipital region of the skull.

(5) The *mastoid processes* (Plate XLIV, p. 14). The superior curved lines end on their posterior borders. The processes form levers by which the splenius and sterno-mastoid muscles act on the skull. Their apices, in the adult, lie at the same level as the occipital condyles and mark the lowest limit of the skull.

(6) The *hairy region of the scalp* extends downwards on the neck for about two inches below the external occipital protuberance.

A Transverse Section of the Neck.—The student will find it of great advantage, before commencing dissection, to examine a transverse section of the neck, such as that shown diagrammatically in figure 266, in order to obtain a clear conception of the arrangement and relationships of the structures he has to find and unravel. He will see that before the posterior aspects of the vertebræ are exposed the following layers of fasciæ and muscles have to be reflected :

(1) Skin.

(2) A thick and dense superficial fascia.

(3) Trapezius and its sheath.

(4) Rhomboids and their sheath ; this layer exists only in the lower part of the neck.

(5) The splenius and its sheath.

(6) The complexus and its sheath.

(7) The semi-spinalis colli. Between this and the sixth layer the deep cervical artery ascends.

(8) The cervical part of the multifidus spinæ.

The short muscles between the atlas and the occipital bone above and the axis below belong to layers 7 and 8. Layers 3 and 4 rise from the middle line of the neck and pass outwards to the upper extremities. Layer 5 rises from the spines and passes outwards and upwards in the neck. Layers 6, 7 and 8 arise from the transverse and articular processes and pass inwards to the spinous processes and occiput.

The posterior divisions of the cervical nerves pierce the muscles; the internal branches of the upper five or six become cutaneous (fig. 268).

Reflection of the Skin.—Four incisions are made thus :

(1) A transverse incision from the upper end of one ear to the upper end of the other, right across the crown of the head and carried down to the bone.

(2) A longitudinal incision in the middle line is made from the transverse incision on the crown to the seventh cervical spine.

(3) A transverse incision from an inch behind one ear to an inch behind the other ear, along the superior curved lines.

The posterior region of the scalp is thus divided into two areas, the right and left occipital segments. They cover the posterior halves of the parietal bones as well as the occipital. These segmental flaps will be dissected later (p. 103), with the rest of the scalp.

(4) A transverse incision from the acromial end of one clavicle to the acromial end of the other, across the seventh cervical spine.

Two flaps are thus marked out over the neck. They are raised from the middle line and thrown outwards, exposing the posterior and postero-lateral aspects of the neck. The skin of the occipital segments of the scalp is also raised upwards for two inches above the protuberance and superior curved lines.

Superficial Fascia.—The subcutaneous tissue is thick and dense; the cutaneous nerves and vessels which lie in it are difficult to find and clean. In this tissue painful boils are apt to occur, especially in the 'collar' line. It is continuous above with the subcutaneous layer of the scalp. Hair roots are imbedded in its upper part. Laterally it becomes less dense as it covers the posterior triangle of the neck.

Cutaneous Nerves (figs. 267, 270 and 278).—The following cutaneous nerves are to be found :—

(1) The *Great occipital* (from the posterior division of the second cervical).

(2) The *Third occipital* (from the posterior division of the third cervical).

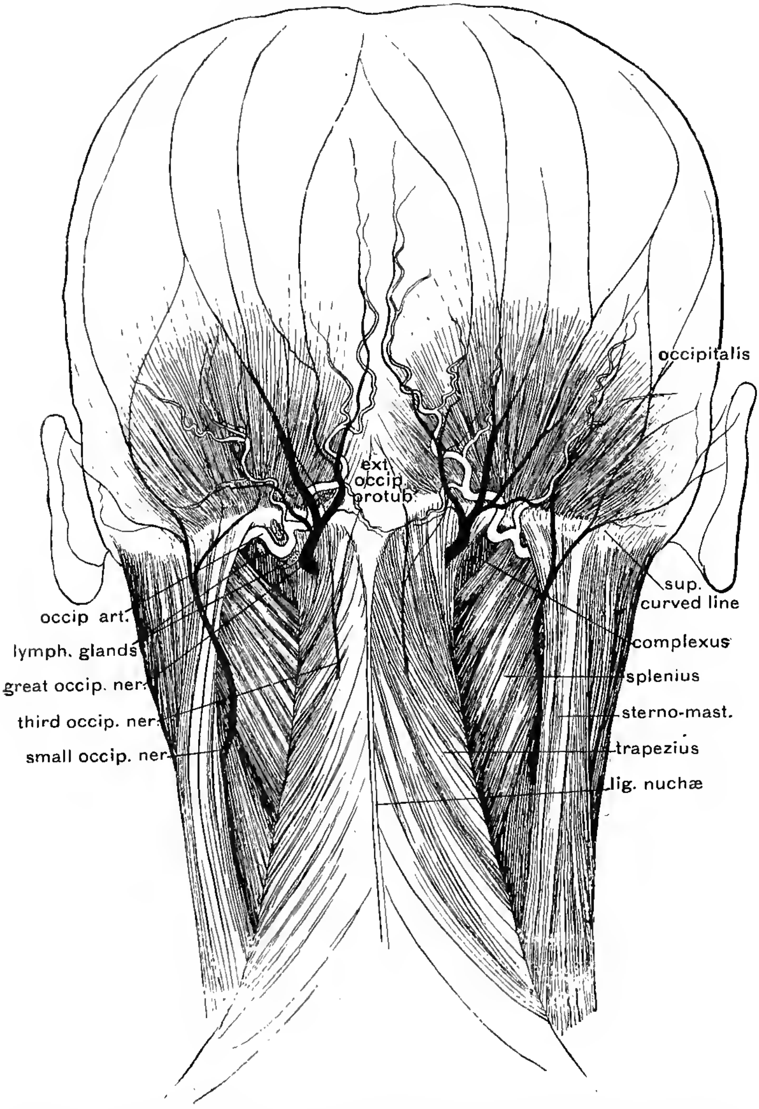
(3) The *Small occipital* (from the anterior divisions of the second and third cervical).

(4) The *Posterior cutaneous* from the posterior divisions of the fourth, fifth, and sixth cervical nerves.

Great Occipital Nerve.—The great occipital nerve of each side supplies the greater part of the occipital segment of the scalp. It will be found firmly imbedded in the cutaneous tissue, crossing the superior curved line one and a half inches from the external occipital protuberance (fig. 267). It pierces the origin of the trapezius muscle and becomes subcutaneous about an inch below the superior curved line. Its course is upwards and outwards. Near the curved line it crosses the occipital artery. Its distribution in the scalp will be followed later (p. 103).

The manner in which the posterior division of a spinal nerve arises may be ascertained by consulting figure 268. The great occipital comes from the posterior division of the

FIG. 267.—THE SUPERFICIAL STRUCTURES ON THE DORSAL ASPECT OF THE HEAD AND NECK. (*F. W. Jones.*)



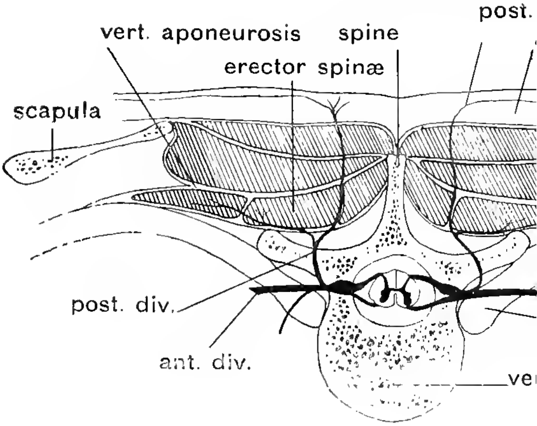
second cervical nerve and represents the internal branch of that division. It forms the first of the series of cutaneous

nerves found in the dorsal region, all
from the posterior divisions of the spinal

Third Occipital Nerve (fig. 267).—Th
the third cervical nerve, corresponding t
It varies in size, but it can commonly
internal to the great occipital nerve, as
occipital protuberance. It becomes cuta
lower down than the great occipital.

Posterior Cutaneous Nerves.—The
downwards the series begun by the two
are very small twigs, which should be loc
is stripped from the trapezius muscle. A

FIG. 268.—THE ORIGIN AND DISTRIBUTION OF THE
SPINAL NERVE.



found from the seventh and eighth cervica
being the spinal nerves which take the gr
the brachial plexus. The limb appears t
of those three nerves, leaving none to su
region of the neck. Their place is tak
shoulder by a *scapular* branch of the desce
This should be looked for over the a
trapezius, above the level of the scapula.

Small Occipital Nerve.—This belong
nerves. It is derived from the anterior
the second and third cervical nerves;
occipital nerves are branches of the pos

nerve-fibres which in one body pass out by the great occipital in others emerge by the small occipital; hence, if the great occipital is unusually small, the small occipital will be found relatively large, and *vice versa*.

The small occipital nerve will be found in the fibrous tissue along the posterior border of the sterno-mastoid (fig. 267). It should be traced back to its origin under the sterno-mastoid, and up to the edge of the scalp. It supplies the scalp between the ear and the distribution of the great occipital. A branch ends on the upper part of the ear.

Occipital Artery.—The occipital artery is firmly imbedded in dense fibrous tissue over the occipital region of the skull. It is most easily found as it crosses the superior curved line about one and a half inches from the external occipital protuberance (fig. 267). It should be traced outwards towards its origin until it sinks beneath the sterno-mastoid. It is a branch of the external carotid artery (fig. 291, p. 61) and reaches the occipital region by passing under the mastoid process and the muscles inserted to it. This, the deep stage of the occipital artery, will be followed later (fig. 273). Only the superficial stage is examined now.

The artery should be traced some little way into the occipital segment of the scalp. Its distribution there will be seen later. It anastomoses with the occipital of the opposite side and with the posterior auricular.

The terminal part of the deep stage, under the sterno-mastoid, should be examined now, the posterior part of the insertion of that muscle being reflected, if necessary. The *mastoid* branch, a meningeal artery, will be seen to enter at the mastoid foramen.

The *occipital veins* form a plexus round the occipital artery. Some of them pass to the external jugular vein on the sterno-mastoid. Some accompany the artery in its deep stage and end in the temporo-maxillary vein. The *mastoid tributary*, an emissary vein, escapes by the mastoid foramen and joins the deep veins. It should be looked for now. It establishes a communication between the lateral sinus and occipital veins. Communicating veins between the occipital and deep cervical veins will be seen as the muscles of the neck are reflected.

Occipital Lymphatic Glands (fig. 267).—In certain diseases these glands may be distinctly felt during life, but it is not easy to find them in the dead body. They lie on each side of the occipital vessels below the superior curved line. They receive lymph from the occipital segment of the scalp, and hence are found enlarged in disease of that structure. The efferent lymphatic vessels pass to deep cervical glands beneath the posterior border of the sterno-mastoid (fig. 284, p. 45).

Occipitalis Muscle (fig. 267).—This small muscle is part of the platysma-sheet of muscles, all of which are subcutaneous and used in expression. It is a muscle of the scalp, and it should be dissected with that structure, but when the body is turned it becomes difficult of access. To see it now the skin and dense subcutaneous tissue of the scalp are to be raised for two inches above the superior curved lines.

ORIGIN.—From the outer two-thirds of the superior curved line and base of mastoid process.

INSERTION.—It becomes continuous above with the epicranial aponeurosis (fig. 321, p. 128).

NERVE SUPPLY.—A twig from the posterior auricular branch of the facial.

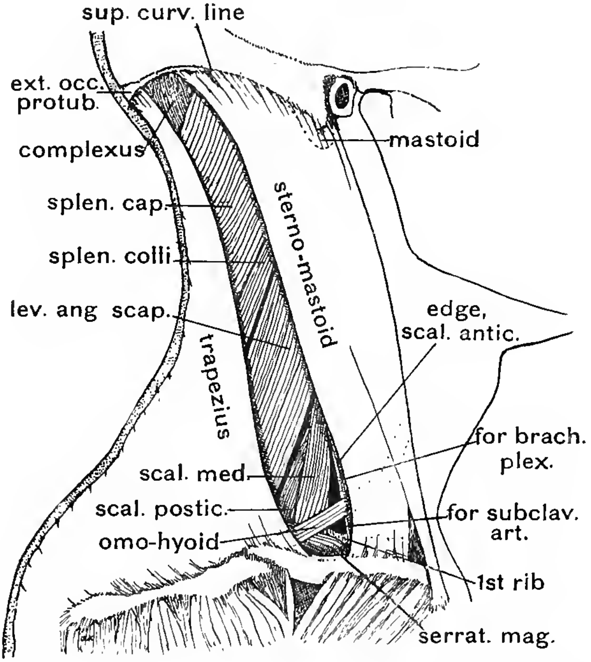
ACTION.—It retracts the scalp. It is frequently partly or wholly fibrous.

Ligamentum Nuchæ.—This is the great median fibrous septum between the right and left extensor muscles of the neck (fig. 266). It cannot be fully examined now, but unless their attention is drawn to it, the dissectors are certain to cut it away unobserved. It is really the expanded cervical part of the inter- and supra-spinous ligaments, which bind the spinous processes together. The cervical spinous processes, with the exception of the sixth and seventh, are very short and bifid. Between their bifid tips the ligamentum nuchæ is attached. The ligamentum nuchæ is attached above to the external occipital protuberance and external occipital spine or crest (Plate XLIII); below to the seventh cervical spine. Between these two points, fibres join it from the spines of the cervical vertebræ. Elastic fibres mingle with the white fibrous tissue of the ligament. In long-necked quadrupeds the elastic tissue is enormously developed, forming a thick yellow band.

The Sheath of the Trapezius and Roof of the Posterior Triangle.—The student meets here for the first time with part of an elaborate structure, known as the *deep cervical fascia*. The cervical fascia is the connective tissue in which the structures of the neck are imbedded and by which they are held compactly together. It forms sheaths for all the muscles, vessels and nerves of the neck.

The sheath of the trapezius and roofing fascia of the posterior triangle of the neck are parts of the deep cervical fascia. When a transverse section of the neck is examined (fig. 266), the sheath of the trapezius is seen to fuse at the median dorsal line with the ligamentum nuchæ and sheath of the opposite side. A layer of the deep fascia is seen to connect the sheath of the trapezius with the sheath of the sterno-mastoid (fig. 266). This layer forms the roof of the space known as the posterior triangle, the boundaries of which are shown in fig. 269. Above it is fixed to the superior curved line; below it is attached to the clavicle. It is a condensed layer of connective tissue; the superficial fascia is attached to its outer aspect; its deep surface is bound by connective tissue to the structures forming the floor of the triangle.

FIG. 269.—THE BOUNDARIES AND FLOOR OF THE POSTERIOR TRIANGLE OF THE NECK.



The deep fascia, which ensheaths the muscles, is now to be raised from the trapezius and the *anterior border* of that muscle defined from its origin at the curved line to its insertion at the clavicle. The roof of the triangle is then raised as far forwards as the posterior border of the sterno-mastoid, but the student is again warned not to look for a very definite membrane, but rather for a condensed layer of connective tissue which he has to define with his knife. As he raises the fascia he must be careful not to cut many important structures which lie in and cross the triangle. As he approaches the sterno-mastoid, he will observe some deep cervical lymphatic glands imbedded in the deep fascia and nerves issuing from beneath the muscle and passing over its posterior border (fig. 270).

Trapezius (cervical part).—This part of the muscle is cleaned and defined and the following points observed:—

ORIGIN.—From the inner third of the superior curved line; from the occipital protuberance; from the ligamentum nuchæ; from the seventh cervical spine. The occipital part of origin is always thin and frequently fibrous.

INSERTION.—To the posterior border of the outer third of the clavicle; to the inner border of the acromion and upper border of the spine of the scapula.

NERVE SUPPLY.—The nerve supply is from the spinal accessory and third and fourth cervical nerves (fig. 270).

BLOOD SUPPLY.—This is derived mainly from the superficial cervical artery (fig. 271).

ACTION.—This part raises the shoulder towards the occiput and assists to elevate the arm to the head.

Spinal Accessory Nerve (fig. 294, p. 71).—Between its origin from the cervical part of the spinal cord and the medulla oblongata, and its termination, the spinal accessory passes through a long and complicated course which for practical purposes may be divided into the following stages:—

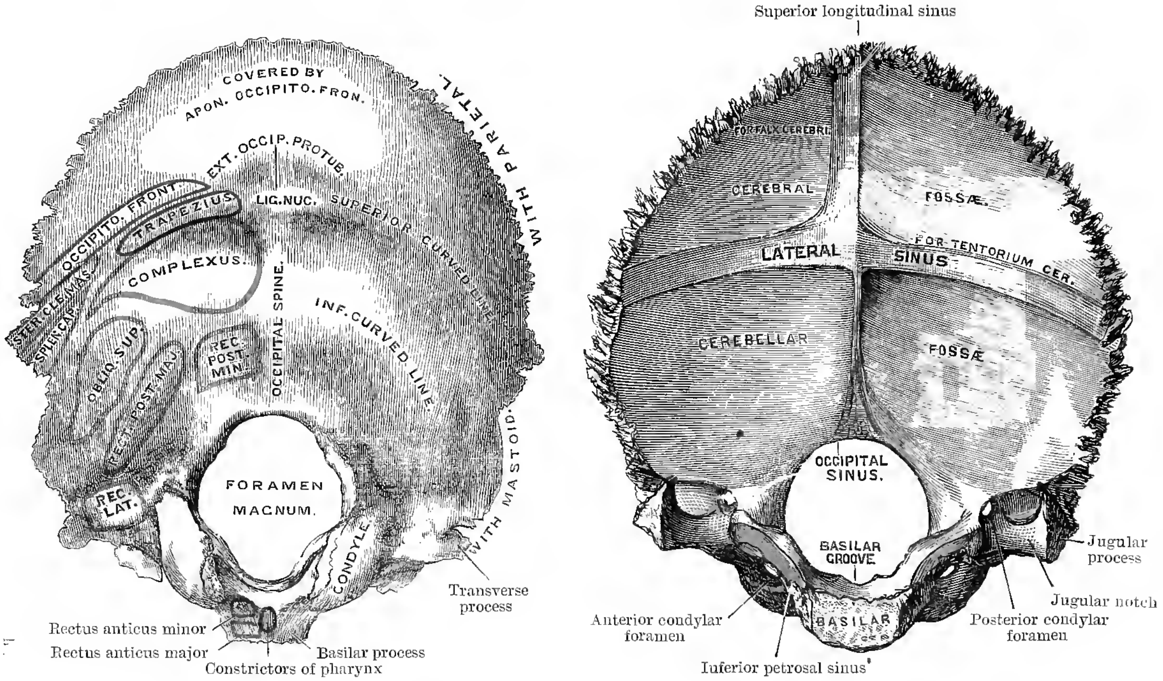
(1) Intra-cranial stage (p. 313).
(2) In sub-parotid space (p. 199).
(3) In superior carotid triangle (p. 61).
(4) In posterior triangle.
(5) Beneath trapezius.

Only the last two stages can be examined now.

STAGE IN THE POSTERIOR TRIANGLE.—The spinal accessory will be found entering the posterior triangle *beneath* the mid-point of the posterior border of the sterno-mastoid (fig. 270).

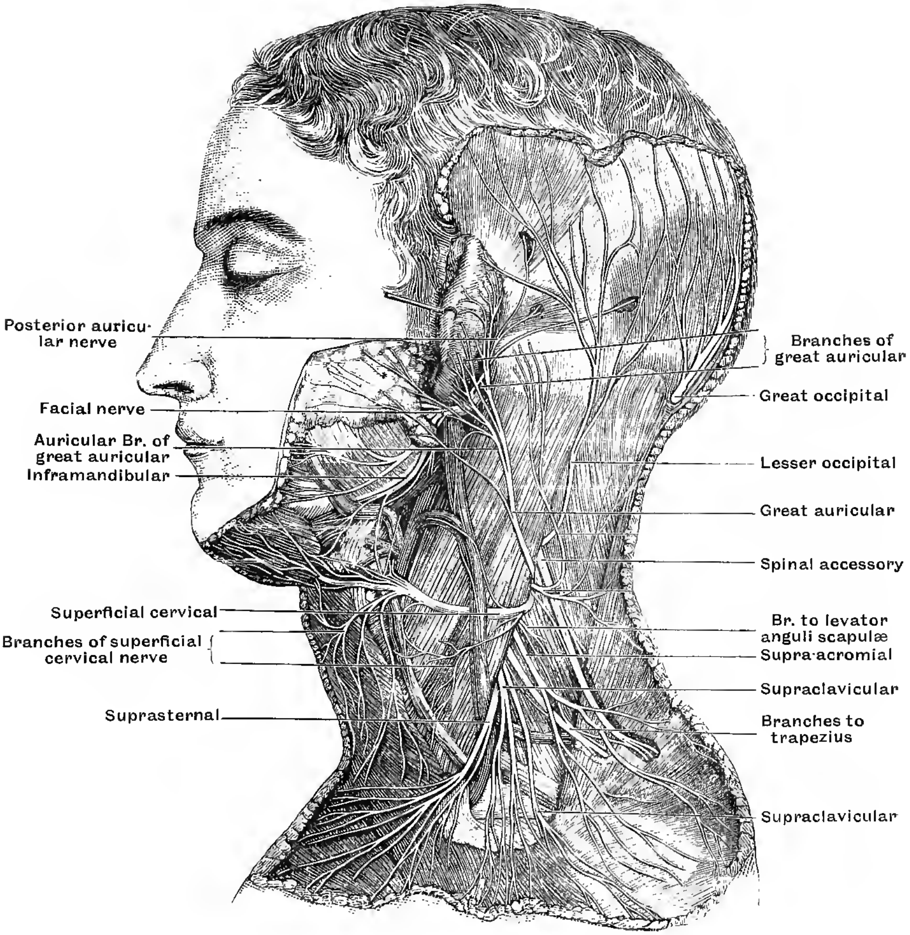
PLATE XLIII

THE RELATIONSHIPS OF THE OUTER AND INNER ASPECTS OF THE OCCIPITAL BONE. (*H. E. Clark.*)



It should be found at this point and traced obliquely downwards and backwards in the triangle beneath the fascia forming the roof. Twigs from the third and fourth cervical nerves join the spinal accessory as it passes beneath the trapezius.

FIG. 270.—NERVES IN THE POSTERIOR TRIANGLE OF THE NECK. (*After Hirschfeld and Leveillé, from Morris's 'Anatomy.'*)



Lymphatic glands lie near it; when enlarged they may surround and press on it.

STAGE BENEATH THE TRAPEZIUS.—It passes beneath the trapezius at a point marked by the junction of the lower and middle thirds of the anterior border of that muscle. A branch from the third and fourth cervical nerves lies near it. The nerves pass downwards, terminating in the muscle, in a line superficial to the vertebral border of the scapula.

Dissection.—The trapezius is now raised neatly from its origin; the dissectors of the arm detach its origin from the spine at the same time. Its sheath is removed as the muscle is turned downwards on the scapula. The trapezius must be kept intact as it is required again in restoring the boundaries of the posterior triangle of the neck.

Superficial Cervical Artery.—As the trapezius is being thrown down, the superficial cervical vessels will be found ramifying on its deep surface near the spinal accessory nerve. When the artery is followed towards its origin, it is found to pass into the posterior triangle, where it arises at the anterior border of the levator anguli scapulæ as a terminal branch of the *transverse cervical artery* (fig. 271). This artery springs from the thyroid axis, a branch of the first stage of the subclavian artery.

The accompanying vein, the *transverse cervical*, passes forwards in the triangle to end in the termination of the external jugular. This should not be traced yet to its termination.

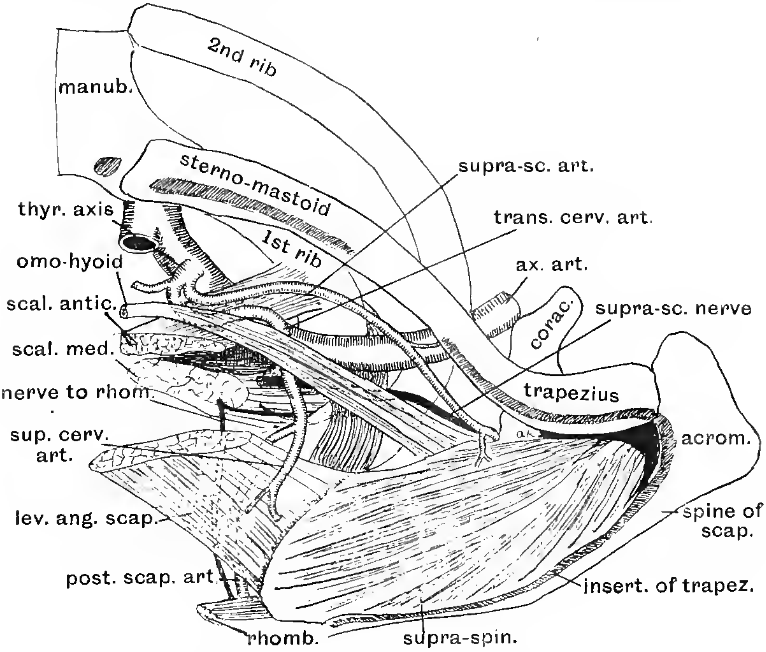
The Rhomboids.—The origin of the rhomboideus minor is from the seventh cervical spine and the ligamentum nuchæ above it. Only the origin of the muscle lies within the cervical region. The rhomboideus major is situated in the dorsal region. The dissectors of the head and neck, however, should help in defining both muscles. Their nerve and blood supply are derived from structures which lie in the posterior triangle.

The nerve to the Rhomboids crosses the posterior triangle (fig. 271). It should be found as it passes beneath the anterior border of the rhomboideus minor near the vertebral border of the scapula. When followed into the triangle it will be seen to issue from the scalenus medius, a muscle forming part of the floor of the triangle. It arises from the fifth cervical nerve.

Posterior Scapular Artery (fig. 271).—The posterior scapular artery passes down the vertebral border of the scapula beneath the insertion of the rhomboid muscles. It supplies the muscles as it passes downwards and also sends branches to the muscles on the dorsum and venter of the scapula, where free anastomoses are formed with the other scapular arteries.

In the majority of bodies the posterior scapular and superficial cervical arteries form the two terminal branches of the transverse cervical artery. At the anterior border of the levator anguli scapulæ (fig. 271) the transverse cervical artery splits into the superficial cervical, which passes over the muscle, and the posterior scapular, which passes deep to it, and then disappears beneath the rhomboids. But the posterior scapular is most variable in its origin. In many bodies it springs as a separate branch from the third stage of the subclavian artery, and, piercing the brachial plexus, reaches its normal course.

FIG. 271.—DIAGRAM OF THE ORIGIN AND COURSE OF THE SUPRA-SCAPULAR AND TRANSVERSE CERVICAL ARTERIES AS VIEWED FROM ABOVE THE RIGHT SHOULDER.



Levator Anguli Scapulæ.—This muscle forms part of the floor of the posterior triangle (fig. 269). Although its origin is in the neck, it is really a muscle of the upper extremity. It raises the angle of the scapula towards the side of the neck, as in shrugging the shoulders. Its terminal part lies beneath the trapezius, its origin beneath the sterno-mastoid. It is difficult to clean. A sheath (part of the deep cervical fascia) surrounds it (fig. 266). The cervical plexus lies between its origin and the overlying sterno-mastoid.

ORIGIN.—From the posterior tubercles of the transverse processes of the upper four or five cervical vertebræ. It arises by tendinous slips.

INSERTION.—To the posterior border of the scapula above the basal triangular surface of the spine.

NERVE SUPPLY.—A branch from the third and fourth cervical nerves.

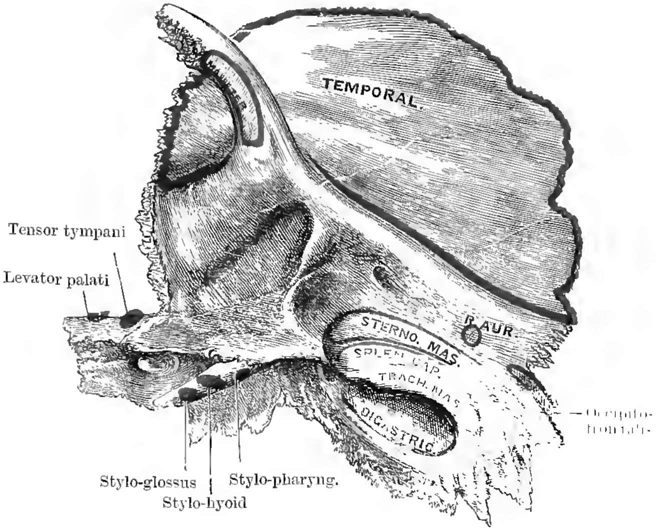
Omo-hyoid.—Only the posterior belly of this curious muscle can now be seen. The anterior belly is attached to the hyoid bone; the posterior belly to the upper border of the scapula, behind the supra-scapular notch (fig. 271). It is at the point of insertion that it must now be found.

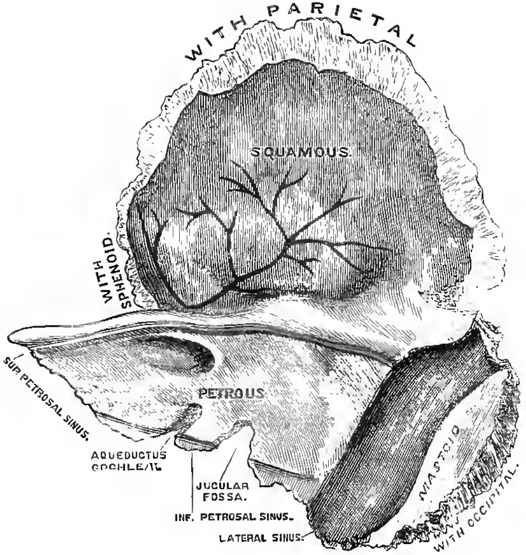
It is surrounded by much fibrous tissue, which should be removed with care. The transverse cervical vessels pass under it. When followed forwards, until it passes beneath the sterno-mastoid, it will be seen to lie deep to, and slightly above, the level of the clavicle. To that bone it is bound by a layer of fibrous tissue (part of the deep cervical fascia), but its relationship to the clavicle must not be disturbed now. The muscle forms one side of the subclavian triangle, the clavicle and posterior border of the sterno-mastoid making up the remaining two (fig. 285, p. 47). Not infrequently, part of the muscle is inserted to the clavicle. These clavicular fibres are left during the foetal migration of the origin of this muscle from the sternum to the scapula along the clavicle. The omo-hyoid and sterno-hyoid are parts of the same embryological sheet of muscle.

Supra-scapular Artery (fig. 271).—The supra-scapular artery is found in front of the insertion of the omo-hyoid muscle, crossing the transverse ligament which bridges the supra-scapular notch. It is distributed to the structures on the dorsum of the scapula and round the shoulder-joint. When followed from the scapula to its origin, it is found to lie close to the clavicle in the subclavian triangle. Its origin is from the thyroid axis (fig. 271), a trunk springing from the first stage of the subclavian artery. Both supra-scapular and posterior scapular arteries anastomose on the scapula with the subscapu-

PLATE XLIV

THE RELATIONSHIPS OF THE OUTER AND INNER ASPECTS OF THE TEMPORAL BONE. (*H. E. Clark.*)





lar and posterior circumflex branches of the axillary, and through these unions a collateral circulation opens up when the subclavian artery is tied in its third stage, or the axillary in its first stage.

The *supra-scapular vein* lies superficial to the artery, and ends in the terminal part of the external jugular.

Supra-scapular Nerve.—The supra-scapular nerve supplies the supra-spinatus, infra-spinatus, and some twigs to the shoulder-joint. It will be found near the artery, passing through the supra-scapular notch beneath the transverse ligament. Its origin can be traced to the upper trunk of the brachial plexus, that trunk being formed by the fifth and sixth cervical nerves (fig. 287).

Splenius.—This muscle forms the third layer of muscles on the back of the neck (fig. 266). The origins of the rhomboids (second layer) have to be reflected to see it. It is covered below by the trapezius; above, its insertion lies beneath the sterno-mastoid; between these two muscles its outer surface forms the upper part of the floor of the posterior triangle of the neck (fig. 269). Posterior divisions of the spinal nerves will be found piercing it. Its sheath is part of the deep cervical fascia (fig. 266).

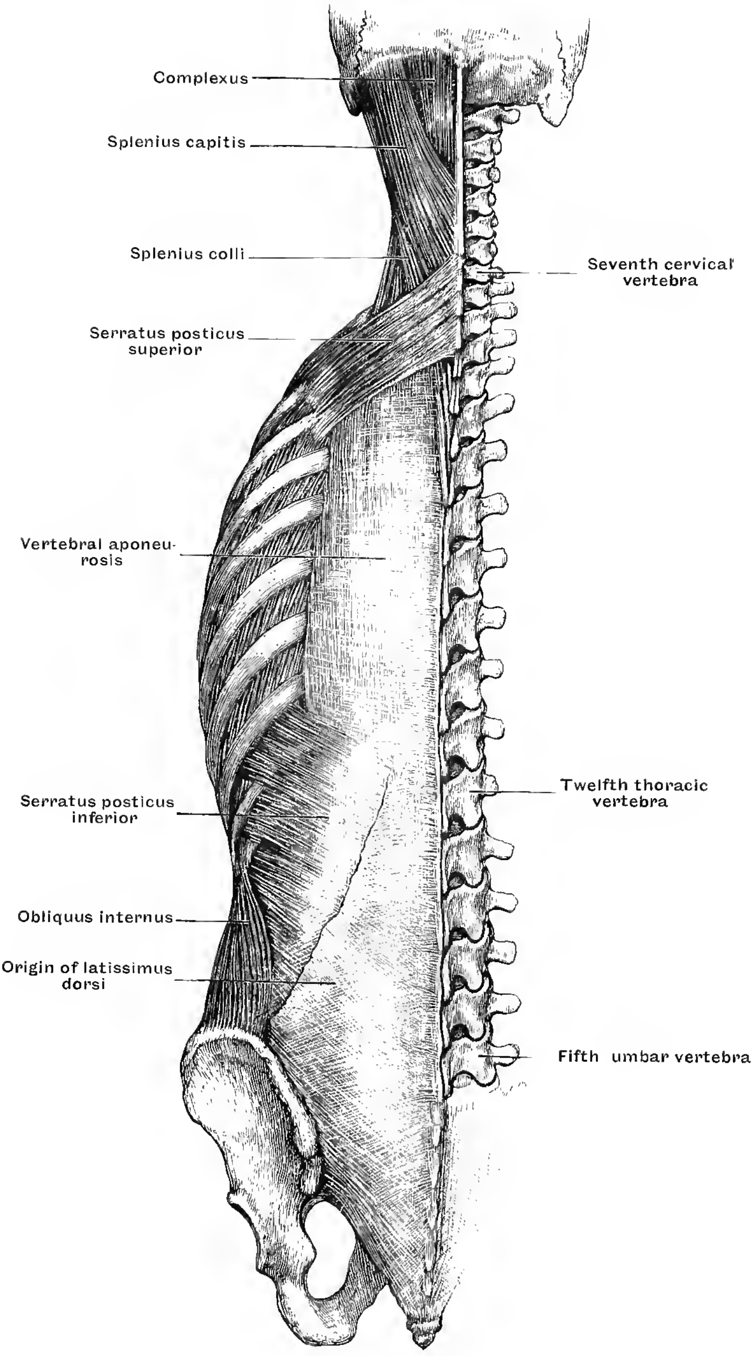
ORIGIN.—From the upper six dorsal spines, seventh cervical spine, and ligamentum nuchæ up to the level of the third cervical spine.

INSERTION.—The fibres from the three lower spines of origin, forming only a small part of the muscle, are inserted to the posterior tubercles of the upper three transverse cervical processes close to the origin of the levator anguli scapulæ. This part forms the *splenius colli.* The remainder forms the *splenius capitis,* and is inserted beneath the sterno-mastoid to the mastoid process and outer third of the superior curved line (Plate XLIV).

NERVE SUPPLY.—From the external branches of the posterior divisions of the cervical nerves.

ACTION.—Both muscles, acting together, extend the head and upper cervical vertebræ. The right muscle rotates and bends the head over the right shoulder; the left over the left shoulder. Each acts with the sterno-mastoid of the opposite side. The sterno-mastoid and splenius muscles, acting together, balance and support the head.

FIG. 272.—THE SPLENIUS, COMPLEXUS, AND VERTEBRAL APONEUROSIS.
(*From Morris's 'Anatomy.'*)


Complexus
Splenius capitis
Splenius colli
Serratus posticus superior
Vertebral aponeurosis
Serratus posticus inferior
Obliquus internus
Origin of latissimus dorsi
Seventh cervical vertebra
Twelfth thoracic vertebra
Fifth umbar vertebra

Complexus.—The splenius muscle is to be raised at its origin from the spinous processes and turned forwards as far as its insertion. It must not be cut away, as it will be required in the examination of the posterior triangle. The complexus is seen beneath it. The fibrous tissue forming the deep sheath of the splenius and the superficial of the complexus is to be cleaned away, and the complexus muscle thus exposed (fig. 272). The great occipital and posterior divisions of the upper cervical nerves will be found perforating the complexus, but the lower nerves appear at its inner border. If the occipital origin of the trapezius is small or absent, as it often is, the insertion of the complexus appears in the floor of the posterior triangle. It forms the fourth layer of muscles of the neck (fig. 266).

ORIGIN.—From the transverse processes of the upper six or seven dorsal vertebræ; from the transverse process of the seventh cervical and *articular* processes of the lower four cervical. Fibres frequently join it from some of the cervical spines.

INSERTION.—From this wide origin the fibres are gathered into a rounded body in the upper part of the neck, on each side of the ligamentum nuchæ (fig. 272), and are inserted into a well-marked impression on the occipital bone between the superior and inferior curved lines, and at each side of the external occipital spine or crest (Plate XLIII).

The inner part of the muscle is commonly isolated, and has an intermuscular tendon, a remnant of an intersegmental septum, corresponding in nature to those seen in the rectus abdominis. The semi-detached part is known as the *biventer cervicis*.

NERVE SUPPLY.—From branches of the posterior divisions of the cervical nerves.

ACTION.—It is the chief extensor muscle of the head and cervical part of the spine. Important structures lie beneath it; they will be examined presently.

Posterior Triangle of the Neck.—The splenius, rhomboids, and trapezius muscles are to be replaced in their natural positions. By demarcating certain regions, such as the posterior triangle, the arrangement of parts is more easily remembered, and a knowledge of them more readily applied clinically.

(1) BOUNDARIES (fig. 269, p. 9).—(*a*) The posterior border of the sterno-mastoid forms the *anterior* boundary.

(*b*) The anterior border of the trapezius forms the *posterior* boundary.

(*c*) The clavicle forms the *lower* boundary or base.

(*d*) The middle part of the superior curved line forms the *apex* or superior boundary.

(2) Roof.—The roof is formed by a layer of fascia joining the sheaths of the trapezius and sterno-mastoid; it is covered by the superficial fascia and skin.

(3) Floor.—The following muscles appear in the floor from above downwards (fig. 269):—(*a*) complexus (occasionally), (*b*) splenius, (*c*) levator anguli scapulæ, (*d*) scalenus medius and posticus, (*e*) first digitation of the serratus magnus.

(4) Divisions.—The posterior belly of the omo-hyoid divides the posterior triangle into two parts, the *occipital* triangle, the upper and larger part, and the *subclavian* or supra-clavicular triangle, the lower and smaller part (fig. 269). The contents of the subclavian triangle will be examined in the anterior dissection of the neck.

Contents of the Occipital Triangle.

(1) Lymphatic Glands (fig. 284, p. 45).—Some occur beneath the posterior border of the sterno-mastoid, others above the posterior belly of the omo-hyoid. These glands belong to the inferior set of *deep cervical glands.*

(2) Nerves.—Most of these have been already examined. They are (fig. 270): (1) the spinal accessory, (2) the nerve to the trapezius from the third and fourth cervical, (3) the nerve to the rhomboids, (4) the nerve to the levator anguli scapulæ. Near the mid-point of the posterior border of the sterno-mastoid emerge (5) the small occipital, (6) the great auricular, (7) the superficial cervical and (8) the descending cervical, all branches of the cervical plexus. The small occipital and descending cervical nerves lie in the roof of the triangle.

(3) Vessels.—(1) The occipital artery and vein cross the apex of the space. (2) The transverse cervical artery enters the triangle from below and divides within it. (3) Small branches of the ascending and deep cervical vessels also appear in the triangle. The transverse cervical vein passes forwards within the triangle.

Trachelo-mastoid.—This thin, strap-like muscle will be recognised by its *insertion* to the posterior border of the mastoid beneath the insertion of the splenius (Plate XLIV). It *rises* side by side with the complexus muscle from the upper dorsal transverse processes and lower cervical articular processes (fig. 275). It balances the head laterally on the spine, and is supplied by external branches of the posterior divisions of the cervical nerves.

Parts seen beneath the Complexus.—The insertion of the complexus to the occipital bone is cleanly raised and the muscle thrown downwards. The fibrous tissue forming the deep sheath of the muscle adheres firmly to the structures lying beneath it, and requires careful dissection. The splenius muscles are removed; the rhomboids and trapezius are already quite detached from the spines. When these steps have been taken, the following structures are seen to lie beneath the complexus:

(1) The sub-occipital triangle and contents (fig. 273).

(2) The deep cervical vessels.

(3) The posterior divisions of the upper cervical nerves (fig. 278).

(4) The semi-spinalis colli (fig. 277).

Deep Cervical Artery.—The deep cervical artery arises from the second stage of the subclavian with the superior intercostal artery (fig. 384, p. 225). It corresponds to the dorsal branch of an intercostal artery, and passes backwards between the neck of the first rib and seventh cervical transverse process to lie beneath the complexus. It ascends beneath that muscle and on the semi-spinalis colli, sending branches to the surrounding muscles. A terminal branch enters the sub-occipital triangle and joins with the *princeps cervicis*, a branch of the occipital, and with the third or sub-occipital stage of the vertebral (fig. 273). The ascending cervical artery passes upwards in front of the transverse processes, and communicating branches pass between it, the vertebral, and the deep cervical (fig. 384).

The *deep cervical vein* is also known as the posterior vertebral, the anterior vertebral accompanying the ascending cervical artery. The posterior vertebral vein forms a plexus round the deep cervical artery and passes with it to the front of the neck. It receives tributaries from the occipital veins and veins of the spinal plexus and ends in the vertebral vein.

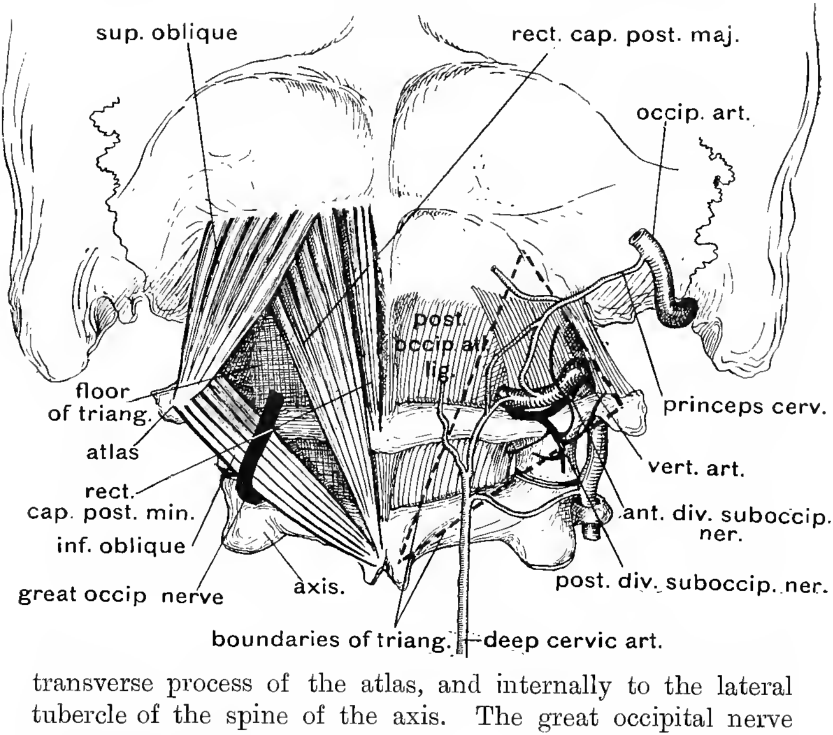
Sub-occipital Triangle (fig. 273).—The dense fibrous tissue which ensheaths the contents and limiting muscles of this space makes its dissection difficult.

1. Boundaries.—(*a*) The inner boundary is formed by the *rectus capitis posticus major* (fig. 273) When cleaned, it is

seen to arise from the spine of the axis by a narrow origin, while as it passes upwards and outwards, its fibres spread out and are inserted to the inferior curved line beneath the superior oblique (Plate XLIII). It partly covers the *rectus capitis posticus minor*, (fig. 273), which passes from the posterior tubercle of the atlas to the occipital bone beneath the inferior curved line (Plate XLIII). It lies beneath the complexus.

(*b*) The lower boundary is formed by the *inferior oblique*, a muscle attached externally to the posterior tubercle of the transverse process of the atlas, and internally to the lateral tubercle of the spine of the axis. The great occipital nerve turns round its lower border.

FIG. 273.—THE BOUNDARIES AND CONTENTS OF THE SUBOCCIPITAL TRIANGLE. (*F. W. Jones.*)



(*c*) The upper and outer border is formed by the *superior oblique*, a muscle rising from the posterior tubercle of the transverse process of the atlas, beside the attachment of the inferior oblique, and passing to an insertion on the occipital bone above the outer half of the inferior curved line and insertion of the rectus capitis posticus major (Plate XLIII).

2. ROOF.—The roof is formed by the complexus and splenius muscles.

3. **Contents.**—To see these the inferior oblique muscle should be removed by detaching its origin and insertion. The following structures are contained in the triangle (fig. 273).

(*a*) SUB-OCCIPITAL OR THIRD STAGE OF THE VERTEBRAL ARTERY.—The outer half of the arch of the atlas and its transverse process should be felt for and exposed with the handle of the scalpel. The vertebral artery, after ascending in the vertebral foramina (second stage), appears on the upper surface of the transverse process of the atlas and enters the triangle. It should be found there and followed behind the lateral articular mass of the atlas, lying in a groove on the upper surface of the arch, until it pierces the membrane between the arch and occipital bone (posterior atlanto-occipital ligament or membrane). The artery then commences its intra-cranial or fourth stage. A branch arises from the artery in the triangle and communicates with branches of the occipital and deep cervical arteries (fig. 273). In the triangle the artery is surrounded by the vertebral plexus of veins.

(*b*) VERTEBRAL PLEXUS OF VEINS.—From this plexus the posterior and middle vertebral veins emerge. Tributaries from the veins and sinuses within the foramen magnum and from the occipital vein end in it.

(*c*) The PRINCEPS CERVICIS, a branch of the occipital artery. In its deep stage, the occipital artery passes along the upper border of the superior oblique muscle and beneath the splenius. Here it gives off this branch (the princeps cervicis), which enters the sub-occipital triangle and anastomoses with branches of the vertebral and deep cervical arteries (fig. 273).

(*d*) POSTERIOR DIVISION OF THE FIRST CERVICAL OR SUB-OCCIPITAL NERVE.—This should be looked for as it emerges between the arch of the atlas and the vertebral artery (fig. 273). It passes into the triangle and sends a branch to each muscle bounding it, to the rectus capitis posticus minor, and to the complexus on its roof. If the artery be raised from the arch of the atlas, the first cervical nerve may be seen dividing into its posterior and anterior divisions. The anterior division passes forwards between the artery and lateral articular mass of the atlas and joins in the cervical plexus in the prevertebral region of the neck. The posterior division of this nerve does not divide into outer and inner branches, as is the case in nearly all the other spinal nerves.

(4) Floor.

The floor of the triangle is formed by :

(*a*) The posterior atlanto-occipital ligament.

(*b*) The posterior arch of the atlas.

(*c*) Part of the posterior atlanto-axial ligament.

Action of the Sub-occipital Muscles.—These short muscles act on two joints :—

(1) The atlanto-axial joints, at which the atlas carrying the head rotates on the axis. (2) The atlanto-occipital joint, where flexion, extension and lateral movements take place between the skull and atlas.

The left *inferior oblique muscle* rotates the atlas and head to the left side ; the right to the right side. The *superior oblique* muscles extend and balance the head on the atlas. The *rectus capitis posticus major* extends the head, and also rotates the head to the side on which it is situated. The *rectus capitis posticus minor* extends the head on the atlas. These four muscles are supplied by the sub-occipital nerve.

Posterior Divisions of the Cervical Nerves.—Each spinal nerve, as it emerges from the intervertebral foramen, divides into an anterior and posterior division (fig. 268). The anterior divisions of the cervical nerves form the cervical plexus and part of the brachial. The posterior divisions pass backwards between the transverse processes, and are now to be examined as they lie beneath the complexus (fig. 278).

The posterior division of the *first* nerve has just been examined in the sub-occipital triangle. The posterior division of the *second* (fig. 278) emerges below the posterior arch of the atlas and inferior oblique muscle. It gives off an external muscular branch, and terminates as the great occipital, which perforates the complexus and trapezius, and is distributed in the occipital segment of the scalp. The posterior division of the *third* appears below the transverse process of the axis. In its course and distribution it resembles the last. The terminal cutaneous branch forms the third occipital nerve (fig. 267). The posterior divisions of the *fourth* and *fifth* are small, and only a twig of the internal branch ends in the skin.

The posterior divisions of the *sixth*, *seventh*, and *eighth* are found beneath the semi-spinalis muscle, and only minute cutaneous twigs are given off, or these may be altogether absent.

It is probable that the dissectors on the other parts now require the body to be turned. If so, the dissection of the anterolateral aspect of the neck (Dissection III) is proceeded with while that of the spinal muscles is deferred until the limbs have been detached. By an arrangement with the dissectors of the abdomen, the body may afterwards be turned again upon its face for a couple of days, when the spinal muscles may be examined (Dissection II) and the spinal cord extracted. If, however, time still remains, the dissectors should proceed to examine the muscles of the back.

DISSECTION II

THE MUSCLES OF THE SPINE

The spinal cord, its canal, and the muscles of the spine are all within the province of the dissectors of the head and neck.

As a rule the student fails to grasp the importance of the muscles of the spine; they appear to him extremely complicated, and an acquaintance with them only of value for examinations. A few years in the practice of his profession will show him that he is mistaken. They are the muscles which keep the spine erect. If, from fatigue or from some constitutional defect, they do not act properly, the spine becomes deformed. It is only by a correct understanding of the action of these muscles, and by training them in a systematic manner, that he can hope to restore the spine to its normal form.

Vertebral Aponeurosis (fig. 272).—The vertebral aponeurosis covers the muscles of the spine as they ascend between the angles of the ribs and spinous processes. It is a thin, distinct, fibrous membrane which is attached externally to the angles of the ribs, and internally to the spines and supraspinous ligaments. The serratus posticus inferior (fig. 272) forms part of it; indeed, the fascia appears to be the remains of a great sheet of muscle, of which the serratus posticus inferior and superior are the only muscular parts now remaining. The vertebral aponeurosis passes beneath the superior serratus muscle, and ends on the sheath of the splenius and complexus. Below it becomes continuous with the posterior layer of the lumbar aponeurosis.

Serratus Posticus Superior (fig. 272).—It lies superficial to the vertebral aponeurosis and beneath the rhomboids.

ORIGIN.—From the upper two or three dorsal spines and lower part of the ligamentum nuchæ.

INSERTION.—To the second, third, fourth, and fifth ribs, external to their angles.

NERVE SUPPLY.—Branches from the upper intercostals.

ACTION.—It elevates the upper ribs, but as a rule is partly fibrous, and of little strength.

Serratus Posticus Inferior (fig. 272).—It is continuous with the vertebral aponeurosis.

ORIGIN.—From the two lower dorsal and two upper lumbar spines.

INSERTION.—To the lower four ribs, external to their angles. The insertion to the twelfth rib is always small, and frequently absent.

NERVE SUPPLY.—From the lower intercostals.

ACTION.—It draws the ribs downwards and backwards, thus assisting the diaphragm, and acting as a muscle of inspiration.

These two muscles and the vertebral aponeurosis are to be completely removed.

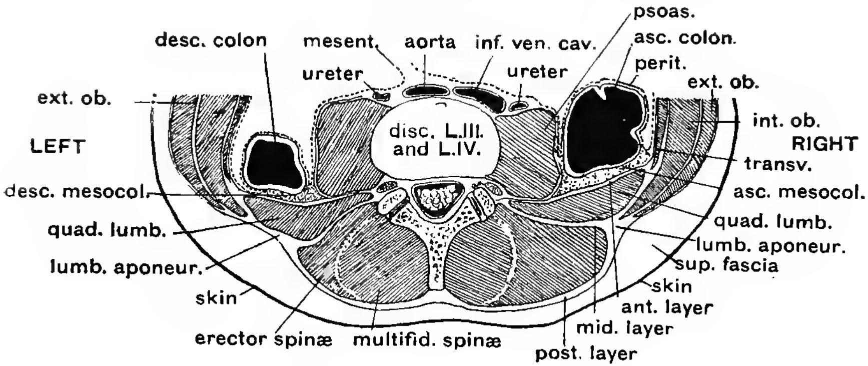
Lumbar Aponeurosis.—The lumbar aponeurosis has been already cleaned and examined by the dissectors of the abdomen (p. 6, Part II). Its *posterior* and *middle* layers form a sheath for the erector spinæ in the lumbar region (fig. 274).

The *middle layer* of the lumbar aponeurosis passes in front of the erector spinæ, and is attached to the tips of the transverse processes. Above, it ends on the last rib; below, on the inner lip of the crest of the ilium and ilio-lumbar ligament.

The *posterior layer* passes behind the erector spinæ, and ends on the tips of the lumbar spines and supra-spinous ligament. Above it is continuous with the vertebral aponeurosis and serratus posticus inferior. Below it becomes adherent to, and inseparable from, the tendon of origin of the erector spinæ. The tendon of origin of the latissimus dorsi is continuous with the posterior layer of the lumbar aponeurosis.

TENDON OF ORIGIN OF THE ERECTOR SPINÆ.—When the posterior layer of the lumbar aponeurosis is removed and the lumbar and sacral spines, supra-spinous ligament, and posterior part of the crest of the ilium clearly defined, the tendon of origin of the erector spinæ is exposed with its attachments (fig. 275). It forms a wide, strong, aponeurotic layer of tendinous bands which arise from:—(*a*) the tips of the lower two or three dorsal and all the lumbar and sacral spines; (*b*) the posterior aspect of the two lower sacral vertebræ, the posterior sacro-iliac ligaments and sacral attachments of the sacro-sciatic ligament. The gluteus maximus arises from this attachment of the tendon. (*c*) The posterior fifth of the iliac crest. The tendon reaches up as far as the mid-dorsal region.

FIG. 274.—THE ANTERIOR, MIDDLE, AND POSTERIOR LAYERS OF THE LUMBAR APONEUROSIS.

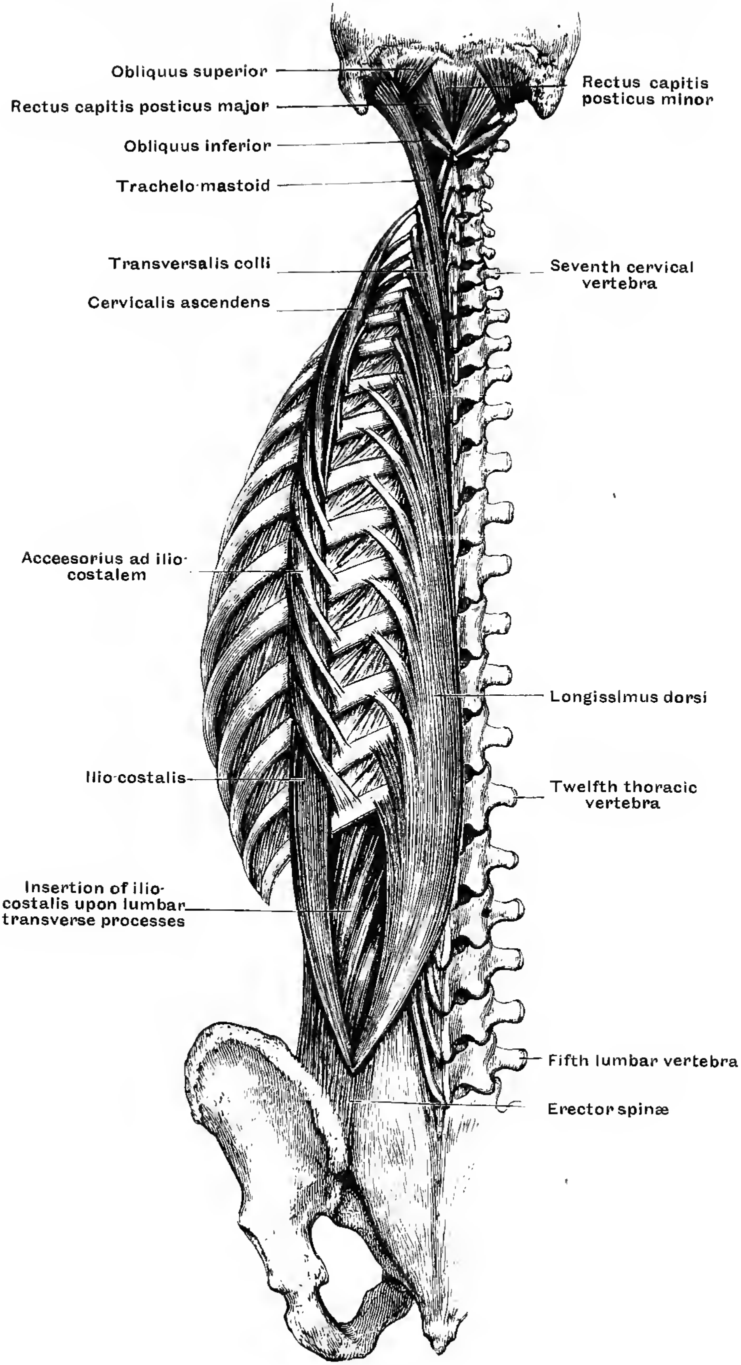


It is of great strength. From its outer edge and deep surface arises the greater part of the erector spinæ. From its deep surface over the sacrum the multifidus spinæ takes origin.

Erector Spinæ.—This muscle forms a rounded mass on each side of the lumbar spines. It divides, as it enters the dorsal region, into three columns of fasciculi, outer, middle, and inner (fig. 275).

In order to understand the arrangement and action of the erector spinæ, the student should examine its three columns about the level of the seventh pair of ribs (fig. 276). A fasciculus of the *outer column* is inserted at the angle of the rib and another arises. The *middle column* sends a fasciculus outwards to be inserted to the shaft of the rib, and a tendon inwards to

FIG. 275.—THE ERECTOR SPINÆ AND ITS PROLONGATIONS IN THE NECK. THE OUTER AND MIDDLE COLUMNS ARE SEPARATED. (*From Morris's 'Anatomy.'*)

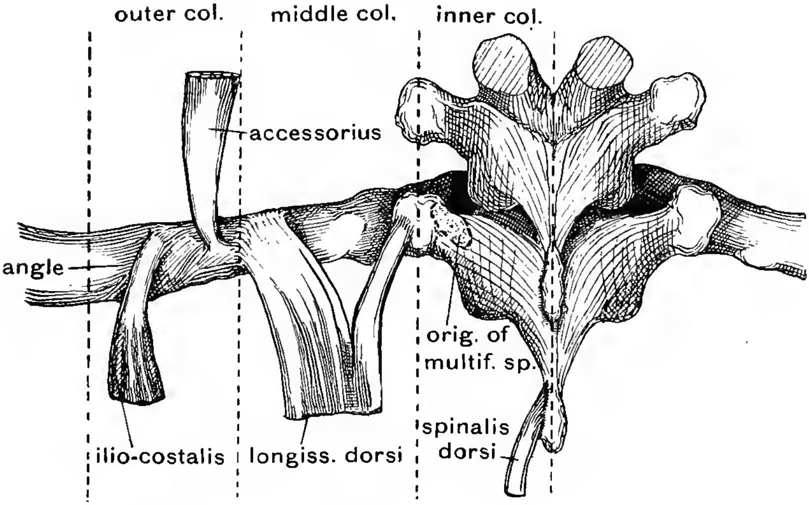

Obliquus superior
Rectus capitis posticus major
Obliquus inferior
Trachelo-mastoid
Transversalis colli
Cervicalis ascendens
Acceesorius ad ilio-costalem
Ilio-costalis
Insertion of ilio-costalis upon lumbar transverse processes
Rectus capitis posticus minor
Seventh cervical vertebra
Longissimus dorsi
Twelfth thoracic vertebra
Fifth lumbar vertebra
Erector spinæ

the tip of the transverse process of the corresponding vertebra. The *inner column* is small; its fasciculi end on the spinous processes.

OUTER COLUMN.—Three muscles are included in this column:

(1) *Ilio-costalis* (fig. 275).—It arises from the tendon of origin and directly from the crest of the ilium. It is inserted to the transverse (costal) processes of the lumbar vertebræ and the six lower ribs at their angles. It depresses and pulls backwards the lower ribs. It uses the ribs as levers to act on the vertebræ. It extends and may rotate the lumbar vertebræ.

FIG. 276.—A RIB AND VERTEBRA SHOWING THE ATTACHMENTS OF THE ERECTOR SPINÆ. (*F. W. Jones.*)



(2) *Accessorius ad ilio-costalem* (fig. 275).—This continuation upwards of the outer column arises from the angles of the six lower ribs, and is inserted to the six upper ribs and seventh cervical transverse process. The fasciculi can approximate the ribs and thus straighten the back.

(3) *Cervicalis ascendens* (fig. 275).—It is composed of two or three small fasciculi, which continue the last muscle upwards. It rises from two or three of the upper ribs, and ends on the two or three lower cervical transverse processes. These fasciculi extend and balance the neck.

Middle Column.—Two muscles are included in this column:

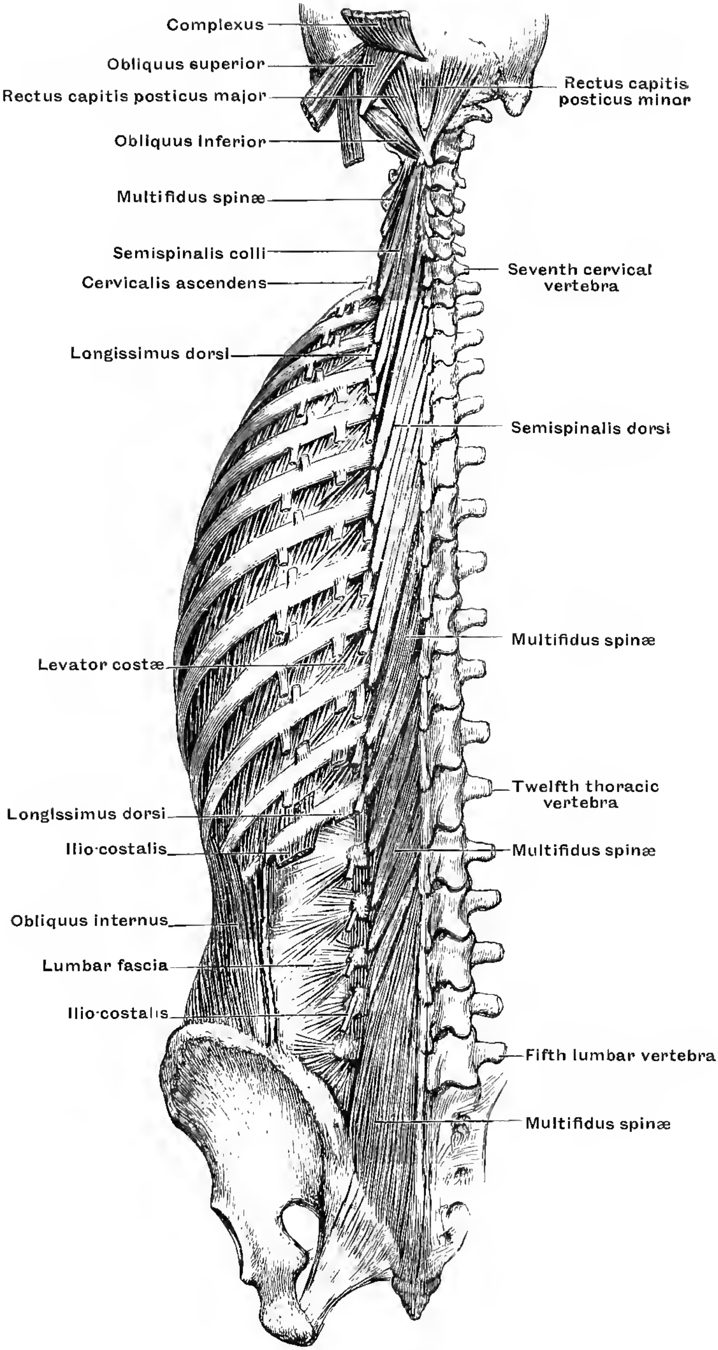
(1) *Longissimus Dorsi* (fig. 275).—This muscle composes almost the entire middle column. It *rises* from the deep surface of the tendon of origin. It is inserted (1) to the accessory and transverse processes of the upper lumbar vertebræ; (2) to the shafts of the nine lower ribs; (3) to the transverse processes of the corresponding dorsal vertebræ. This is the principal erector muscle of the spine. It acts on the vertebræ through the ribs and transverse processes, and through these may rotate the vertebræ. If one muscle acts more than another it tends to rotate the bodies of the vertebræ towards its own side and thus gives rise to a deformity known as scoliosis of the spine.

(2) *Transversalis Cervicis* (fig. 275).—It continues the middle column into the neck. The fasciculi which compose it *rise* from the tips of the upper four or five dorsal transverse processes; they are *inserted* to the posterior tubercles of the transverse processes of the lower four or five cervical vertebræ. The fibres of both sides, if they act together, extend the cervical part of the spine; the right muscle, acting alone, rotates the neck and head towards the right, the left towards the left.

Inner Column.—This column is made up of a series of muscular fasciculi, known as the *spinalis dorsi.* It is a muscle peculiar to man. The fasciculi are closely applied to the lower lumbar spines. They arise from the lower dorsal and upper lumbar spines and from the tendons of origin of the longissimus dorsi. They are inserted to the middle dorsal spines between the third and eighth.

Posterior Divisions of the Dorsal and Lumbar Nerves (fig. 278).—The posterior division of a nerve enters the back by a passage bounded by a transverse process above and below; the articular processes and their capsule on the inner side, and the superior costo-transverse or inter-transverse ligament on the outer side. As each posterior division appears on the back, it divides beneath the middle column of the erector spinæ into an inner and outer branch, one passing to the inner side of the column, the other to the outer side (fig. 278). The internal branches of the upper six dorsal, the external of the lower six dorsal and upper three lumbar nerves, give off posterior

FIG. 277.—THE MULTIFIDUS SPINÆ AND SEMISPINALIS. (*From Morris's 'Anatomy.'*)



cutaneous branches. The branches from the lumbar nerves cross the crest of the ilium. They perforate the erector spinæ and appear at its outer border (fig. 278).

The erector spinæ, all the extensor muscles of the back, as well as the skin on the dorsal aspect of the body, are supplied by the posterior divisions of the nerves.

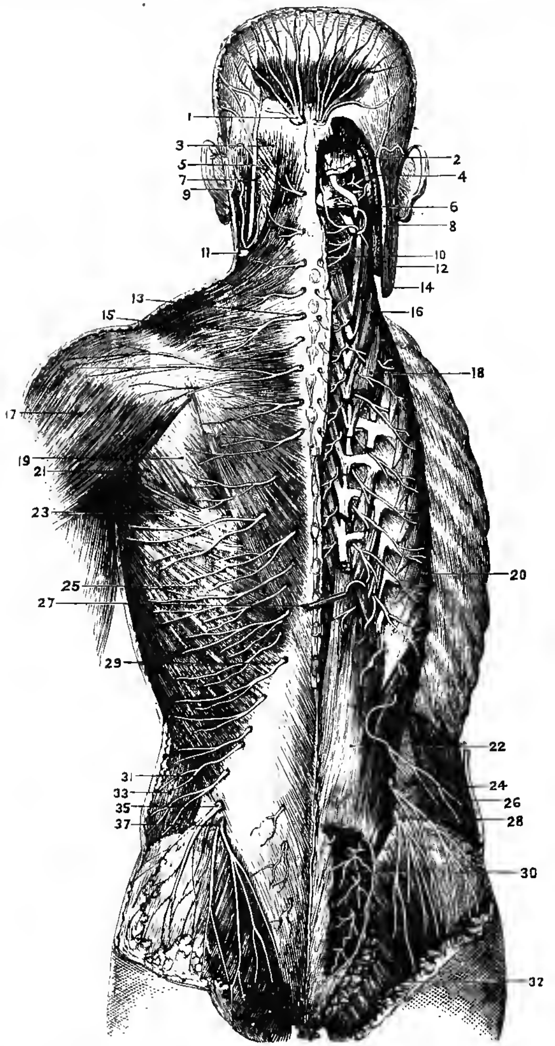
POSTERIOR BRANCHES OF THE DORSAL AND LUMBAR VESSELS.—The manner in which dorsal branches of the intercostal and lumbar arteries arise is shown in fig. 279. Each branch accompanies the corresponding nerve, and ends in the muscles and skin of the back. The veins communicate freely with the plexuses of veins which lie on the outer and inner aspects of the spinal canal.

DISSECTION.—The tendon of origin of the erector spinæ is to be detached from the spines and sacrum ; the three columns are raised from the ribs, transverse processes and spines, and the whole muscle cleanly removed. Beneath it lies the *multifidus spinæ,* a muscle composed of many fasciculi, which pass obliquely upwards and inwards and span three or four vertebræ (fig. 277). In the dorsal and cervical regions a superficial lamina of the multifidus layer is distinguished as the *semispinalis.* In the dorsal region a deep layer of its fasciculi forms the *rotatores dorsi.*

Semispinalis (fig. 277).—The semispinalis is composed of fasciculi which rise from the transverse processes of the upper ten dorsal vertebræ; they form a continuous layer. The fasciculi pass upwards and inwards and are inserted to the spines from the second cervical to the fifth dorsal. The fasciculi inserted to the spine of the axis are specially strong. The part inserted to the cervical spines (2–5) is distinguished as the *semispinalis colli,* the remainder as the *semispinalis dorsi.* The complexus covers the upper part of the muscle ; the deep cervical vessels lie between them. Superficial to the muscle will be found the internal branches of the posterior divisions of the second, third, fourth and fifth cervical nerves ; the internal branches from the lower cervical nerves lie beneath it.

Multifidus Spinæ (fig. 277).—The multifidus spinæ is composed of fasciculi which rise from the transverse and articular processes, and pass obliquely inwards and upwards to the spines of two or three vertebræ higher up. The fasciculi which com-

FIG. 278.—THE NERVES OF THE BACK. (*From Hirschfeld and Leveillé.*)

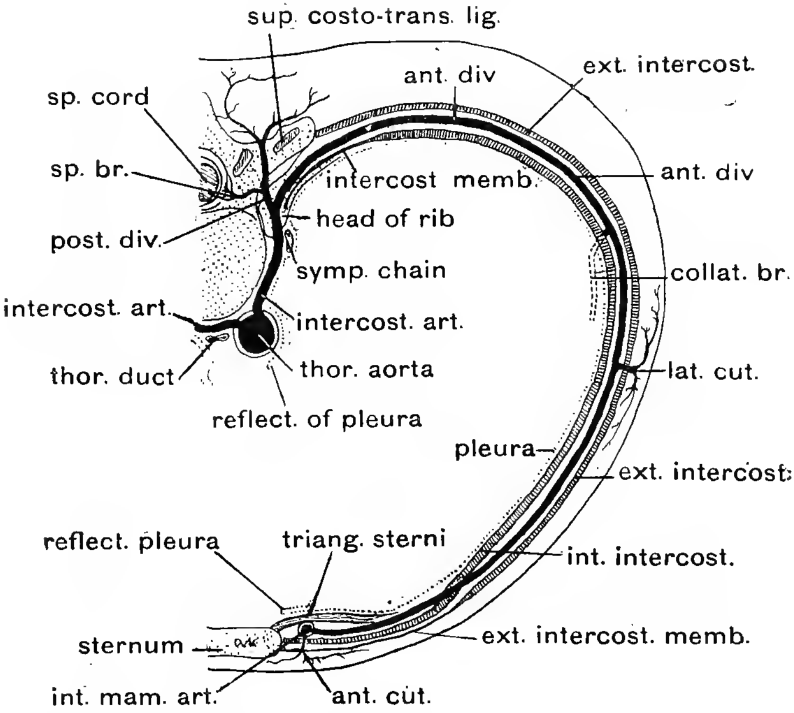


1. Great occipital nerve. 2 and 3. Complexus muscle. 4 and 5. Splenius capitis. 6. Great occipital nerve. 7 and 8. Small occipital nerve. 9. Sterno-mastoideus. 10. Semispinalis colli. 11. Superficial cervical nerve. 12. Levator anguli scapulæ (cut). 13. Eighth cervical nerve. 14. Sterno-mastoid (cut). 15. Trapezius. 16. Trachelo-mastoideus. 17. Deltoid. 18. Transversalis colli. 19. Infra-spinatus. 20. Ilio-costalis. 21. Teres minor. 22. Erector spinæ. 23. Teres major. 24. External branch of posterior primary division of first lumbar nerve. 25. Latissimus dorsi. 26. Obliquus internus. 27. Longissimus dorsi. 28. External branch of posterior primary division of lumbar nerves. 29. Posterior division of eleventh dorsal nerve. 30. Posterior divisions of sacral nerves. 31. Posterior division of first lumbar. 32. Gluteus maximus. 33. Obliquus externus. 35 and 37. Posterior divisions of second and third lumbar nerves.

pose it must be regarded as agents for rotating and balancing the vertebræ, and maintaining the spine erect; they act from the transverse on the spinous processes, thus maintaining the vertebræ evenly poised on each other. When the muscles of both sides act, they extend the spine by approximating the spinous processes.

The multifidus spinæ is a thick and strong muscle in the SACRAL and LUMBAR REGIONS (fig. 277). It *rises* from the deep surface of the tendon of the erector spinæ, from the posterior aspect of the upper three sacral vertebræ, from the inner aspect of the posterior part of the ilium, and from the sacro-iliac ligaments. The fasciculi pass to the lower borders of the lumbar spines. This part extends the lumbar region of the spine, after stooping, and maintains the lumbar curvature.

FIG. 279.—THE ORIGIN AND DISTRIBUTION OF THE POSTERIOR BRANCH OF AN INTERCOSTAL ARTERY.



In the DORSO-LUMBAR REGION (from the third lumbar to the tenth dorsal, fig. 277) it is also strong. This is the most flexible part of the spinal column. In this region the muscle arises by strong tendons from the mammillary processes, which are special developments to give origin to this part (fig. 277).

The *insertion* is to the spines of the lower dorsal region. In the UPPER DORSAL and CERVICAL region the multifidus is reduced to a thin layer beneath the semispinalis.

ROTATORES DORSI.—In the dorsal region, between the laminæ of the twelve dorsal vertebræ, the deepest fibres of the multifidus spinæ form separate slips, to which this name has been given. They pass from the root of a transverse process to the lower border of the lamina above.

INTERTRANSVERSE MUSCLES.—Those of the neck will be examined later. They consist of anterior and posterior fasciculi uniting the transverse processes.

In the lumbar and lower dorsal regions intertransverse muscular fasciculi will be seen between the transverse processes and also between the articular and mammillary processes.

In the upper dorsal region the intertransverse muscles are represented by fibrous bands.

INTERSPINOUS MUSCLES.—The forked ends of the cervical spines are united by two muscular fasciculi. There are none in the dorsal region. In the lumbar region they pass from spine to spine on each side of the interspinous ligament.

DORSAL SPINAL PLEXUS OF VEINS.—Ramifying on the laminæ of the vertebræ, beneath the multifidus spinæ, will be found the dorsal spinal plexus of veins (fig. 429, p. 297). Communicating veins pierce the ligamenta subflava from the intraspinal plexus and join the dorsal spinal veins. Communicating veins pass on the spinous processes to the subcutaneous veins of the back. The blood of the dorsal spinal plexus drains into the posterior divisions of the intercostal and lumbar veins, and in the neck into the posterior vertebral veins.

After the removal of the brain from the skull the spinal canal is opened and the cord taken out for examination (see p. 113).

DISSECTION III

THE DIVISIONS AND SUPERFICIAL STRUCTURES ON THE ANTERO-LATERAL ASPECT OF THE NECK

BOUNDARIES OF THE NECK.—The neck is continuous *below* with the thorax and shoulder. Its lower limit is indicated superficially by: (1) the upper border of the manubrium sterni, which is marked by the supra-sternal notch and flanked by the sternal ends of the clavicles and origins of the sterno-mastoids; (2) the clavicle; (3) the posterior part of the first rib.

The upper limit of the neck is indicated by a line drawn from the external occipital protuberance along the superior curved line to the mastoid process, and continued forwards on the lower border of the mandible to the symphysis. The finger should be passed along this line and these points examined.

The neck is continuous *above* with the structures bounding the buccal and pharyngeal cavities, the sub-parotid and superficial parotid spaces (p. 173), and the base of the skull below the level of the superior curved line and mastoid process.

Divisions of the Neck.—The regions into which the neck is divided are shown in fig. 280, and they should be identified now on the part for dissection. On each side there are the four following divisions:

(1) ANTERIOR TRIANGLE OF THE NECK (fig. 280).—The *base.*—The base is above, and is formed by the lower border of the mandible and a line continuing that border backwards to the anterior edge of the sterno-mastoid.

The *anterior boundary* is formed by the middle line of the neck between the symphysis menti above and the supra-sternal notch below. It separates the right from the left anterior triangle.

The *posterior boundary* is formed by the anterior border of the sterno-mastoid, a prominent landmark on the neck, stretching between the sterno-clavicular joint and anterior border of the mastoid process. This boundary shows a marked anterior convexity.

(2) POSTERIOR TRIANGLE OF THE NECK (figs. 280 and 269, p. 9).

The *base*; middle third of the clavicle.

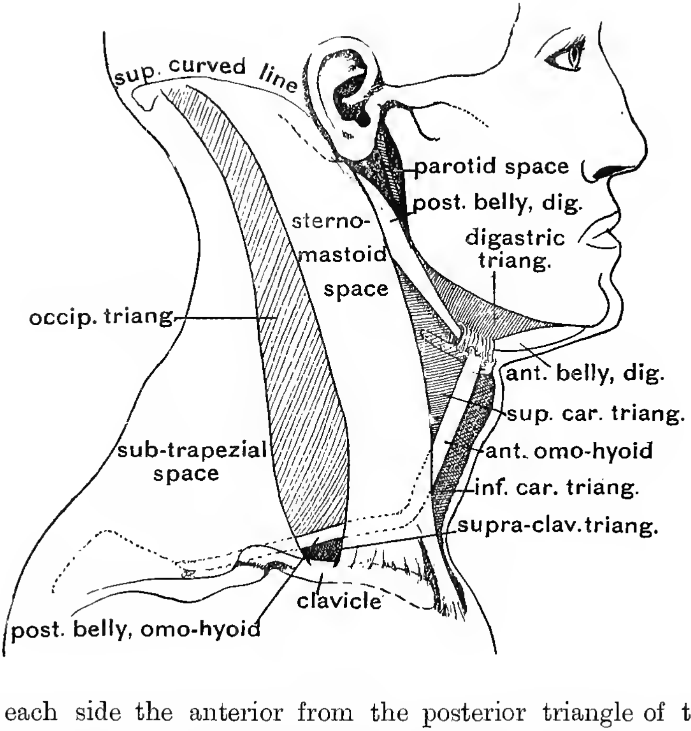
The *anterior boundary*; posterior border of the sterno-mastoid.

The *posterior boundary*; anterior border of the trapezius.

The *apex* is situate at the superior curved line between the attachments of the sterno-mastoid and the trapezius.

(3) STERNO-MASTOID SPACE (fig. 280).—It is bounded *in front* by the anterior border of the sterno-mastoid, and *behind* by the posterior border of the muscle. The muscle separates on each side the anterior from the posterior triangle of the neck and covers the STERNO-MASTOID SPACE (fig. 280), in which lie many of the most important structures of the neck. The dissector will find that for surgical and clinical purposes the borders of the sterno-mastoid are the principal guides to the deep-lying structures. All the preliminary incisions to reach the structures situated in the sterno-mastoid space are made either at the anterior or posterior border of the muscle.

FIG. 280.—THE TRIANGLES AND SPACES INTO WHICH EACH SIDE OF THE NECK IS DIVIDED.



A knowledge of the contents of the space is the key to the arrangement of structures in the neck.

(4) TRAPEZIAL DIVISION.—Behind the posterior triangle there is still a triangular part of the neck remaining after the three parts mentioned above have been demarcated; it is covered by the cervical part of the trapezius. This may be called the trapezial division.

Sub-divisions of the Anterior Triangle.—The Anterior Triangle is divided into three minor triangles by two muscles, the digastric and omo-hyoid (fig. 280). The three triangles are:

(1) The Submaxillary or Digastric Triangle.
(2) The Superior Carotid Triangle.
(3) The Inferior Carotid or Muscular Triangle.

The position of the anterior belly of the omo-hyoid, which separates the superior from the inferior carotid triangle (fig. 280), may be indicated thus:—The body of the hyoid bone, to which the omo-hyoid is attached, can be felt about one and a half inches behind and slightly below the level of the symphysis menti; a point on the posterior border of the sterno-mastoid, an inch above the clavicle, indicates the lower end of the anterior belly of the omo-hyoid. A line joining these two points indicates the position of the anterior belly of the omo-hyoid and the boundary-line between the superior and inferior carotid triangles.

The anterior part of the posterior belly of the digastric muscle separates the superior carotid from the sub-maxillary triangle, and both bellies form the two lower boundaries (anterior and posterior) of the submaxillary triangle. The position of the anterior belly is indicated by a line drawn from the lower border of the jaw, half an inch from the symphysis menti, to the junction of the body with the great and small horns of the hyoid (the *lateral hyoid point*). This point is readily felt in the living body. A line from the angle of the jaw to the lateral hyoid point indicates the posterior inferior boundary of the submaxillary triangle. The upper boundary of the submaxillary triangle is formed by the lower border of the mandible, the anterior belly of the digastric bounding it in front.

The submaxillary gland can be felt in the submaxillary triangle; the superior carotid triangle contains the division of the common carotid into external and internal carotid arteries.

Subdivisions of Posterior Triangle.—The posterior triangle is subdivided by the posterior belly of the omo-hyoid into (1) SUBCLAVIAN (supra-clavicular) and (2) OCCIPITAL triangles (fig. 269, p. 9).

The position of the subclavian triangle is indicated in life by the supra-clavicular fossa. It contains the subclavian vessels and the lower part of the brachial plexus. The *anterior or inferior boundary* is formed by the clavicle ; its short *base* is formed by the lowest inch of the posterior border of the sterno-mastoid ; the position of its *upper boundary*, formed by the posterior belly of the omo-hyoid, may be indicated by a line drawn from the posterior border of the sterno-mastoid, an inch above the clavicle, to the outer end of the clavicle.

The student will see that, with a knowledge of the position and arrangement of three muscles, the sterno-mastoid, omo-hyoid and digastric, he can readily find his way to the triangles and structures of the neck.

REFLECTION OF THE SKIN.—Three incisions are made to reflect the skin from the neck :—

(1) From the symphysis menti to the supra-sternal notch.

(2) From the supra-sternal notch to the outer end of the clavicle. As the skin in front of the clavicle is thin, the incision over it must be made lightly, otherwise the descending cervical nerves will be divided.

(3) From the symphysis menti along the lower border of the jaw, straight backwards over the mastoid process to the superior curved line. The flap of skin thus marked out is raised at the middle line and thrown outwards. The platysma myoides lies in the subcutaneous tissue. The skin is to be preserved to wrap the part in, between dissections.

Platysma Myoides (fig. 321, p. 128).—The platysma is a thin sheet of muscle, situated in the subcutaneous tissue over the lateral aspects of the neck. It is part of a great muscular stratum found beneath the skin of the face, scalp and neck. The whole of this sheet or stratum (muscles of the face, scalp and ear) is devoted to the purposes of expression ; in it and by it, the mental states are reflected and manifested. The more complex the brain, the more highly specialised is this sheet. The student will find that the platysma contracts and raises the skin below the chin and jaw, when his more energetic passions have been roused. The whole sheet—platysma, muscles of the face, scalp and external ear—is supplied by one nerve, the seventh cranial or facial.

Origin.—From the subcutaneous tissue over the upper and outer part of the pectoralis major, and upper part of the deltoid, a few fibres also rising from the clavicle.

Insertion.—The fibres pass upwards and inwards, meeting and crossing with the fibres of the opposite side for an inch below the symphysis. The deeper fibres are inserted below the external oblique line of the lower jaw (Plate LII, p. 180). The more superficial end in the muscles of the lower lip and outer angle of the mouth.

Nerve Supply.—As the muscle is raised from its origin and reflected upwards, the infra-mandibular or cervical branch of the facial will be found passing beneath it, behind the angle of the jaw.

Action.—It depresses the jaw and retracts the angle of the mouth. In passion, the jaw is fixed; the tense muscle raises the skin over the anterior triangle of the neck. This may afford protection for the deeper structures, but it is to be regarded rather as the reflection of a mental state of which its contraction forms an intrinsic part.

Superficial Structures of the Neck.—Besides the platysma, there are to be found superficial to the deep fascia and beneath the skin the following structures:—

(1) The cutaneous branches of the cervical plexus (fig. 270, p. 11).

(2) The external and anterior jugular veins (fig. 281).

(3) The superficial lymphatic glands which occur occasionally over the sterno-mastoid along the course of the external jugular vein. These structures are now to be examined, care being taken to keep the deep fascia intact.

Cutaneous Branches of the Cervical Plexus.—The *anterior divisions* of the upper four cervical nerves form the cervical plexus (fig. 295, Plate XLVI). They issue from the spinal canal by the intervertebral foramina beneath the sterno-mastoid and from the loops formed by the second, third and fourth nerves six cutaneous branches are given off; these are now to be found as they perforate the deep fascia and issue near the *mid-point* of the posterior border of the sterno-mastoid, and examined in the following order:

(1) The small occipital (fig. 270, p. 11) has already

been traced along the posterior border of the sterno-mastoid to its distribution in the scalp and ear (p. 6). Its origin is from the second and third nerves.

(2) The GREAT AURICULAR nerve (fig. 270, p. 11) supplies the greater part of the external ear, the skin in front of and behind that structure, and over the upper parts of the sterno-mastoid and anterior triangle of the neck. It should be looked for in a line drawn between the mid-point of the posterior border of the sterno-mastoid and the lobule of the ear. It divides into three branches: one to the ear, one to be afterwards followed to the skin over the parotid and angle of the jaw, and one to the skin over the mastoid. It also arises from the second and third nerves (fig. 295, p. 74).

(3) The SUPERFICIAL CERVICAL nerve (fig. 270, p. 11) passes transversely forwards, across the sterno-mastoid. It divides into branches which supply the skin in front of the neck, over the greater part of the anterior triangle. It arises from the second and third nerves.

There are three DESCENDING CERVICAL NERVES (fig. 270) (supra-sternal, supra-clavicular and supra-acromial), which supply the skin of the neck and chest as far downwards as the level of the third pair of ribs, as well as the skin of the shoulder. They arise from the third and fourth cervical nerves (fig. 295).

(4) The SUPRA-STERNAL is a small branch and passes downwards on the roof of the posterior triangle behind the sterno-mastoid. It crosses the insertion of that muscle to reach the skin over the upper part of the sternum.

(5) The SUPRA-CLAVICULAR descends behind the last and crosses the clavicle near its middle. It is frequently subdivided.

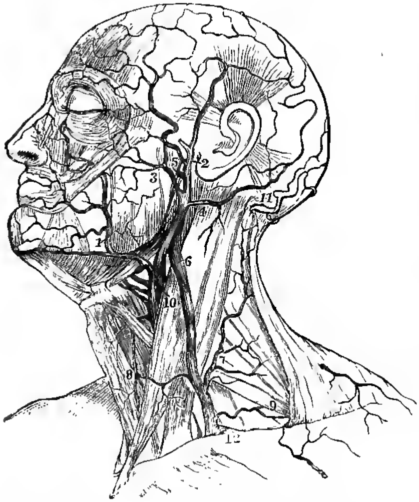
(6) The SUPRA-ACROMIAL is still more posterior. It crosses the acromion and supplies the skin over the upper two-thirds of the deltoid.

There is also a *fourth* descending nerve, behind the last, which ends in the skin over the upper part of the scapula.

It will be noticed that the cervical nerves encroach on the area of skin one would expect to be supplied by the lower cervical and upper dorsal nerves. It has been already seen that the principal nerves of the extremities appear to be so monopolised by the limb that they have no branches to spare for the skin of the trunk.

Superficial Veins of the Neck.—(1) External Jugular Vein.—The formation of this vein is shown in figs. 270, p. 11, and 281. It arises in the parotid gland from the temporo-maxillary vein, and passes obliquely downwards to perforate the deep fascia at the posterior border of the sterno-mastoid, half an inch above the clavicle. The platysma covers the vein. It is extremely variable in size; in some bodies it may be a mere twig, in others it is one of the main veins of the neck and forms a marked prominence over the sterno-mastoid during active exertion.

Fig. 281.—The superficial veins of the head and neck. (*Quain.*)



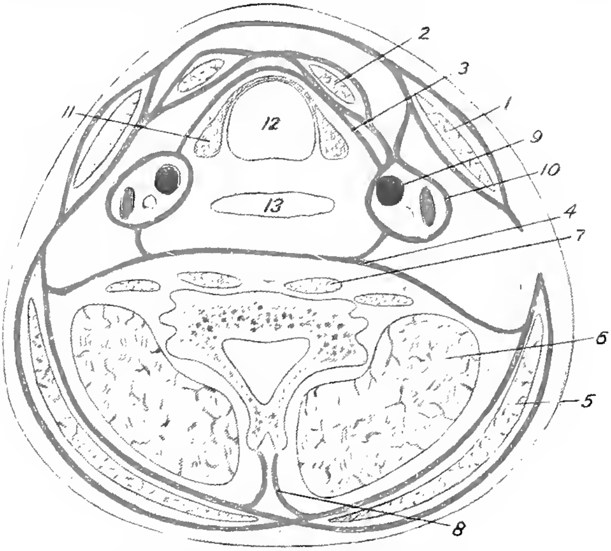
Superficial veins of the head and neck. 1. Facial. 2. Temporal. 3. Transverse facial. 4. Posterior auricular. 5. Internal maxillary. 6. External jugular 7. Posterior external jugular. 8. Anterior jugular. 9. Posterior scapular. 10. Internal jugular. 11. Occipital. 12. Subclavian.

Tributaries.—The posterior auricular vein (fig. 281, 4) joins it on the sterno-mastoid; a branch from the occipital may pass down the posterior border of the sterno-mastoid, receive branches from over the posterior triangle, and end in it. Beneath the deep fascia, the transverse cervical and supra-scapular veins join it; so does the next vein, the anterior jugular. A twig, crossing the clavicle, may unite it with the cephalic.

(2) Anterior jugular vein (fig. 281, 8).—The size and arrangement of this vein are even more irregular than the external. As a rule it commences in some twigs from the submaxillary gland and passes downwards on the roof of the anterior triangle until the suprasternal notch is almost reached. There a vein along the anterior border of the sterno-mastoid joins it. The anterior jugular vein perforates the deep fascia and courses backwards beneath the sterno-mastoid, about an inch above the clavicle, to join the external jugular. In a space of the deep fascia above the sternum a communicating twig unites the two anterior jugular veins together.

PLATE XLV

A DIAGRAMMATIC SECTION OF THE NECK TO SHOW THE ARRANGEMENT OF THE DEEP CERVICAL FASCIA. (*Hughes.*)



The deep cervical fascia is indicated by a blue line.

1. Sterno-mastoid. 2. Sterno-hyoid. 3. Pre-tracheal layer. 4. Retro-pharyngeal and Pre-vertebral layers. 5. Trapezius. 6. Deep extensor muscles of the neck. 7. Longus colli. 8. Ligamentum nuchæ. 9. Common carotid artery. 10. The carotid sheath containing the jugular vein, common carotid artery, and vagus nerve. 11. Thyroid body.

Deep Cervical Fascia (Plate XLV).—Those parts of the deep cervical fascia which form the sheath of the trapezius muscle and the roof of the posterior triangle have been examined already (see p. 8, fig. 266, p. 2). The arrangement of the remaining parts of this fascia is to be examined now. Much help will be obtained by a reference to a section of the neck, such as that shown diagrammatically in Plate XLV and fig. 282. Again the student is reminded that he must not seek for definite membranes; the cervical fascia is the connective tissue in which the structures of the neck are imbedded; it forms their sheaths and binds them together. It plays the same part to the structures of the neck as mortar does to bricks in a wall. It must be remembered, too, that it is a living structure, one liable to inflammatory changes and rich in its supply of lymphatic vessels.

The following parts are now to be examined (fig. 282):

(1) The sheath of the sterno-mastoid.
(2) The roof of the anterior triangle.
(3) The capsule of the submaxillary gland.
(4) The carotid sheath.
(5) The sheath of the infra-hyoid group of muscles.
(6) The axillary sheath.
(7) The prevertebral and retro-pharyngeal fasciæ.
(8) The stylo-maxillary ligament.

The superficial nerves and veins are removed, and the surface of the deep fascia cleaned with the forceps and handle of the scalpel.

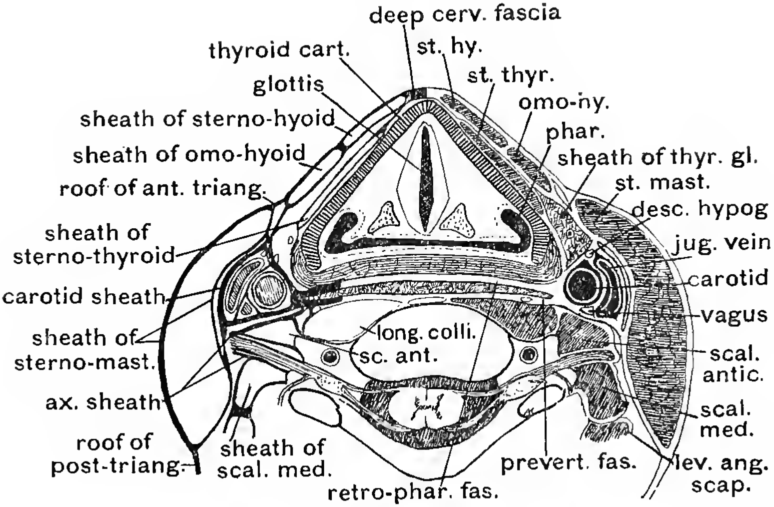
(1) The SHEATH OF THE STERNO-MASTOID (fig. 282).—The sterno-mastoid is enclosed in a strong sheath, which is attached at the bony points of origin and insertion. Behind it is continuous with the deep fascia roofing over the posterior triangle; in front it is continuous with that covering the anterior triangle. Its deep surface is continuous with the carotid sheath (fig. 282).

(2) The ROOF OF THE ANTERIOR TRIANGLE is continuous posteriorly with the sheath of the sterno-mastoid; in front it meets with the fascia covering the opposite triangle in the middle line of the neck; along the middle line it fuses with the sheaths of the infra-hyoid layer of muscles (fig. 282). About an inch above the sternum it becomes quite free from the sheaths of the infra-hyoid layer, and is attached to the

anterior border of the sternum. The fascia covering the anterior surfaces of the sterno-hyoid and sterno-thyroid muscles is attached at the posterior border of the sternum. Thus there is a small space (the supra-sternal or Burn's space) above the sternum, between the two layers of the deep cervical fascia mentioned above (fig. 283); in this space the communicating vein between the anterior jugular veins crosses; a small lymphatic gland is occasionally found in it.

Above, the fascial roof of the anterior triangles ends on the lower border of the jaw and the sheath of the parotid gland.

Fig. 282.—A section of the neck to show the parts of the deep cervical fascia.



In the middle line it fuses with the periosteum on the body of the hyoid.

(3) The FASCIAL CAPSULE OF THE SUB-MAXILLARY GLAND is formed thus. The fascia just described covers the sub-maxillary gland, but if it be cut through immediately below the gland, it will be seen to be attached to the body of the hyoid and to send a deep layer under the gland which passes upwards to be attached to the mylo-hyoid ridge of the jaw. Thus the sub-maxillary gland is contained in a compartment between the deep and superficial attachments of the fascial roof of the anterior triangle to the body of the mandible.

(4) The CAROTID SHEATH may be viewed by removing

completely the fascial roof of the anterior triangle. The sheath will then be seen to be adherent to the deep surface of the sterno-mastoid (fig. 282). Where the common carotid divides into internal and external carotid arteries, a little below the level of the hyoid bone, the artery comes out from under cover of the sterno-mastoid muscle and the sheath becomes adherent to the fascial roof of the superior carotid triangle. Septa divide the fascial sheath into three compartments, one for the internal jugular vein externally, one for the common carotid internally, and one for the vagus behind (fig. 282).

The carotid sheaths are bound together in front of the trachea by the sheaths of the infra-hyoid layer of muscles; behind the œsophagus and pharynx the carotid sheaths are joined together by the retro-pharyngeal and prevertebral layers of fascia (fig. 282).

The carotid sheath passes with the internal carotid artery and jugular vein to the base of the skull, where it is attached mainly to the vaginal process; it strengthens and protects the vessels during extension of the neck.

Followed downwards into the thorax, it surrounds the innominate artery and veins and becomes continuous with the fibrous sheath of the aorta and pericardium. Thus, through the continuity of their fibrous sheaths and fascia, the organs of the thorax obtain a certain amount of support from the structures of the neck (fig. 282).

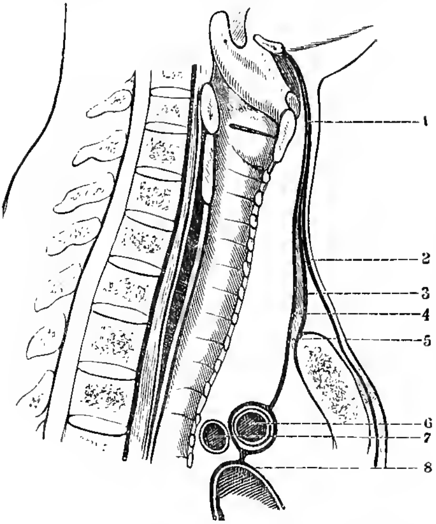
(5) The SHEATH OF THE INFRA-HYOID LAYER encloses the sterno-hyoid, sterno-thyroid and omo-hyoid muscles. In front of the trachea it is continuous with the corresponding layer of the opposite side (fig. 282). In the middle line, except for an inch above the sternum, it is adherent to the more superficial layer which forms the roof of the anterior triangle. It is continuous under the sterno-mastoid with the carotid sheath (fig. 282). With the carotid sheaths it is continued into the thorax, and becomes adherent to the ensheathing structures of the thorax (fig. 283). Above, it is continuous with the thin capsule of the thyroid body; behind, with the loose connective tissue surrounding the trachea and œsophagus.

Owing to the migration of the origin of the omo-hyoid from the sternum along the clavicle to the scapula, part of this layer has been drawn out under the sterno-mastoid and over the supra-clavicular triangle. Thus, to expose the contents of the supra-clavicular triangle, two layers of deep fascia have to be cut through, although the distinction between the roofing layer of the posterior triangle and the omo-hyoidal layer is not always well marked.

(6) The AXILLARY SHEATH.—Below the middle third of the clavicle the subclavian vein enters the neck, the subclavian artery and brachial plexus pass outwards to the arm. The subclavian vein and artery are surrounded by a sheath directly continuous with the carotid sheath; the nerves of the brachial plexus are surrounded by tissue continuous with the sheaths of the muscles between which they emerge, the scalenus anticus and medius (fig. 282). The connective tissue surrounding and ensheathing the brachial plexus and subclavian vessels, the *axillary sheath*, is part of the cervical fascia. As the structures pass under the clavicle, the subclavius muscle and costo-coracoid membrane, their common sheath adheres to these structures. It is continuous with the sheath of the vessels and nerves of the axilla.

FIG. 283.—DIAGRAM OF THE LAYERS OF THE DEEP CERVICAL FASCIA IN AN ANTERO-POSTERIOR SECTION OPPOSITE TO THE STERNUM. (*Tillaux.*)

(The prevertebral layer can be seen passing down in front of the longus colli.)

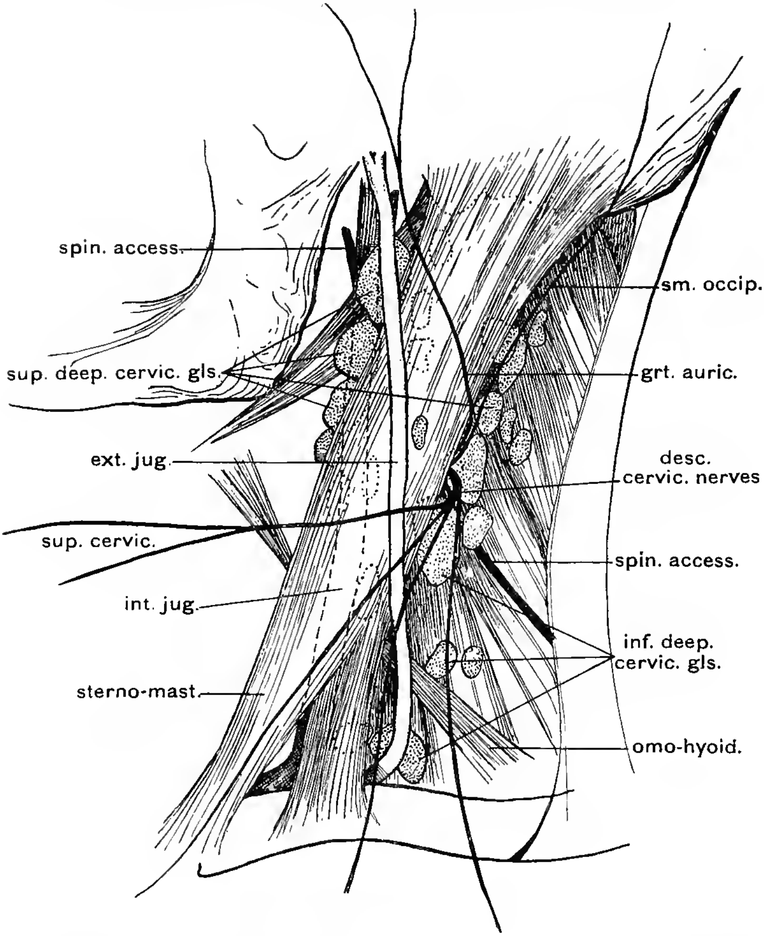


1 and 2. Superficial layer of deep fascia. 3. Deeper layer bounding supra-sternal space behind. 4. Reduplication of this layer passing behind the sterno-thyroid. Tracheal layer, separated from the trachea and enclosing the left innominate vein, becomes continuous with the pericardium. 5. Space occupied by sterno-hyoid. 6. Left innominate vein. 7. Innominate artery. 8. Pericardium.

(7) The PREVERTEBRAL AND RETRO-PHARYNGEAL parts of the deep cervical fascia are united by loose areolar tissue, but a separation is easily effected. They are the layers of connective tissue between the prevertebral muscles and spinal column behind, and the pharynx and œsophagus in front, the one en-

sheathing the posterior structures, the other the anterior. They unite the two carotid sheaths together (fig. 282). They will be examined later, p. 221.

FIG. 284.—THE DEEP CERVICAL LYMPHATIC GLANDS (FROM A PREPARATION IN WHICH THE GLANDS WERE ENLARGED FROM DISEASE). (*F. W. Jones.*)



(8) The STYLO-MAXILLARY LIGAMENT will be seen later, p. 178. It passes from the styloid process to the angle of the jaw and forms part of the capsule of the parotid gland.

Deep Cervical Lymphatic Glands.—None of the structures of the neck require so much clinical attention and surgical interference as the deep cervical lymphatic glands, which are now to be examined. They lie on the superficial aspect of the carotid sheath and beneath the sterno-mastoid (fig. 284). They are divided into two groups: the *upper group* and *lower group.* Sometimes a third group is described, the *superficial* cervical glands lying along the external jugular vein over the sterno-mastoid. Glands in this position are uncommon.

The UPPER DEEP GROUP of lymphatic glands will be exposed by removing carefully the sheath of the upper half of the sterno-mastoid, behind and below the angle of the jaw (fig. 284). They lie over the carotid sheath at the anterior border of the muscle and under it. Probably fifteen or twenty such glands may be seen. When they are inflamed they may adhere to the muscle, to the jugular vein, spinal accessory nerve, or one of the many structures which will be seen presently to lie in this region.

The upper deep group of glands receives the lymph from the tonsil and pharynx ; into them pass the efferent lymphatic vessels of the groups of glands described on p. 102 and shown in fig. 307. In fact, nearly all the lymph-vessels of the head pass to them. In the later stages of cancer of the tongue they become affected.

The LOWER DEEP GROUP of deep cervical glands lies beneath and behind the lower half of the sterno-mastoid (fig. 284). Some are imbedded in the sheath of the sterno-mastoid along the posterior border, and lie amongst the nerves of the cervical plexus. Others lie on the subclavian vein and in the angle between the jugular and subclavian veins, where the thoracic duct on the left side, and the right lymphatic duct on the right, join the innominate veins (fig. 284). The lymph-vessels from the upper extremity, from the axilla and scapular regions, pass to this group. In late stages of cancer of the breast they become involved.

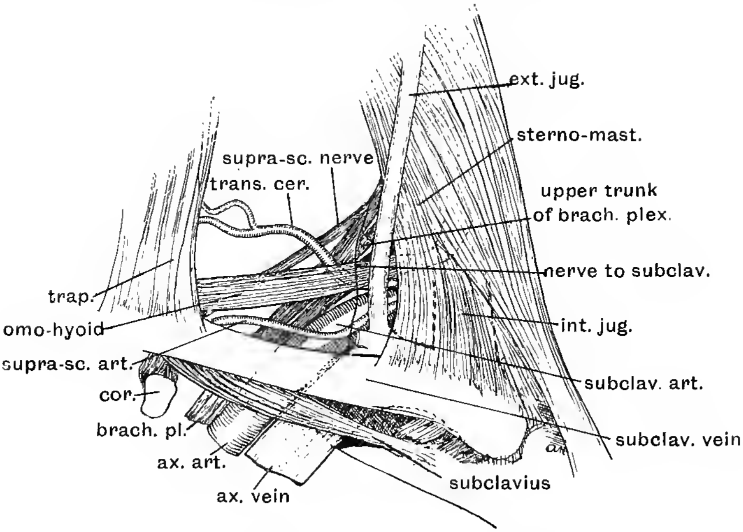
DISSECTION IV

THE POSTERIOR TRIANGLE OF THE NECK

The Posterior Triangle of the neck is divided by the posterior belly of the omo-hyoid into an upper part—the OCCIPITAL TRIANGLE—and a lower, the SUBCLAVIAN or SUPRA-CLAVICULAR triangle. The occipital triangle has been examined already (p. 17); there now remains for dissection the subclavian.

Subclavian or Supra-clavicular Triangle.—The student is now to proceed with the examination of the region of the neck which contains the cervical stages of the vessels and nerves of the upper extremity. While he is working at the subclavian triangle the dissector of the upper extremity is busy with the adjacent region of the axilla, and it is to the benefit of both that the transitional region between the neck and arm should be done together.

FIG. 285.—THE BOUNDARIES AND CHIEF CONTENTS OF THE SUBCLAVIAN TRIANGLE. (*From a preparation by H. F. Warner.*)



(The nerve to sub-clavius lies beneath omo-hyoid.)

The BOUNDARIES (fig. 285) of the subclavian triangle are to be defined first. The fascial roof of the posterior triangle of the neck, of which the subclavian triangle forms but a small part, is to be cut away; the subclavius muscle, its sheath and the costo-coracoid membrane clearly made out on the pectoral or outer aspect. The middle third of the clavicle, subclavius muscle and its sheath form the *inferior boundary* of the triangle. The *upper boundary*, formed by the posterior belly of the omo-hyoid, is difficult to define. It lies rather behind than above the clavicle, the triangle in the upright position occupying nearly a horizontal plane. The *inner boundary* or *base* is formed by the lowest inch of the posterior border of the sterno-mastoid.

Notice the omo-hyoidal part of the deep cervical fascia, beneath the layer already cut away, passing from the sheath of the omo-hyoid to the clavicle in the roof of the triangle. Lymphatic glands may be found in it; the supra-scapular and transverse cervical veins pass across the triangle beneath this layer; the arteries may accompany the veins. This layer is to be removed and the structures within the triangles defined.

The structures which form the FLOOR of the subclavian triangle are shown in fig. 286. The floor is formed by part of the upper surface of the first rib, the origin of the first digitation of the serratus magnus and part of the fibrous dome (Sibson's fascia) covering the apex of the lung.

Contents of Subclavian Triangle (fig. 285).

(1) The nerve to the subclavius.
(2) The subclavian vein.
(3) Termination of the external jugular vein.
(4) The supra-scapular vein.
(5) The transverse cervical vein.
(6) The subclavian artery.
(7) The supra-scapular artery.
(8) The transverse cervical artery.
(9) Part of the brachial plexus.
(10) Part of the long thoracic nerve.
(11) Some of the inferior deep cervical lymphatic glands already described (p. 46).

(1) The NERVE TO THE SUBCLAVIUS rises from the fifth cervical and passes downwards beneath the omo-hyoid and across the subclavian vessels to its muscle (fig. 285). It is frequently united with the phrenic nerve at its origin.

(2) The SUBCLAVIAN VEIN (fig. 285).—To see it clearly, the middle third of the clavicle should be removed, the subclavius

muscle being detached and left *in situ*. The axillary vein ends and the subclavian vein commences at the outer border of the first rib, which is felt below and behind the vein. The fibrous sheath of the vein is firmly adherent in front to the sheath of the subclavius muscle. The vein receives the external jugular as it passes out of the triangle under the sterno-mastoid muscle. The subclavian vein may be torn in fractures of the clavicle; it is partially compressed between the first rib and clavicle by heavy weights carried on the shoulder. The adhesions of its sheath to surrounding structures keep it from collapsing when it is empty. Hence, if wounded, the negative pressure which occurs in this vein during inspiration may suck air into it, causing air embolism. The vein receives no tributary of consequence except the one mentioned above.

(3) The TERMINATION OF THE EXTERNAL JUGULAR VEIN. As it enters the triangle at the posterior border of the sterno-mastoid, it receives the transverse cervical and supra-scapular veins.

(4) The SUPRA-SCAPULAR VEIN passes from the supra-scapular notch across the triangle, close to the clavicle to end in the external jugular.

(5) The TRANSVERSE CERVICAL VEIN (p. 12) crosses the omo-hyoid and enters the triangle. It also ends in the external jugular.

(6) The SUBCLAVIAN ARTERY lies behind and, owing to the downward slope of the first rib, rather above the level of the vein. It emerges in the triangle from behind the scalenus anticus, which separates it from the vein. Above it and behind it are the trunks of the brachial plexus (fig. 285). The axillary sheath surrounds the vessels and nerves. The artery passes obliquely outwards behind the clavicle and the insertion of the subclavius, and at the outer border of the first rib, lying on the first digitation of the serratus magnus, becomes the axillary (fig. 286). It is the third stage of the subclavian artery which lies in the subclavian triangle (fig 300, p. 88). It may be compressed here against the first rib by pressing downwards and backwards. It is here that the artery is tied for axillary aneurism. As a rule no branch rises from this stage, but it is by no means uncommon to find the posterior scapular artery arising from the third stage instead of from the thyroid axis.

(7) The SUPRA-SCAPULAR ARTERY passes outwards close to

the deep surface of the clavicle. It rises from the thyroid axis (Plate XLVI, p. 70) and crosses the upper border of the scapula at the supra-scapular notch. It supplies branches to the supra-spinous fossa and muscle, infra-spinous fossa and muscle, and shoulder-joint. The nutrient artery for the clavicle rises from it as it passes outwards behind the clavicle. (See also p. 14.)

(8) The TRANSVERSE CERVICAL ARTERY also crosses the upper part of the triangle. It commonly passes under the omo-hyoid muscle, and over the brachial plexus to the anterior border of the levator anguli scapulæ, where it divides into *superficial cervical* and *posterior scapular* (p. 12 and fig. 271).

(9) Behind the artery and within the triangle lies the lower trunk of the BRACHIAL PLEXUS; the middle trunk lies above it (p. 52).

(10) The LONG THORACIC NERVE (nerve of Bell) perforates the insertion of the scalenus medius and passes on to the serratus magnus. It leaves the neck behind the brachial plexus; it passes behind the termination of the subclavian artery and commencement of the first stage of the axillary artery, and lies in the triangle for a short part of its course.

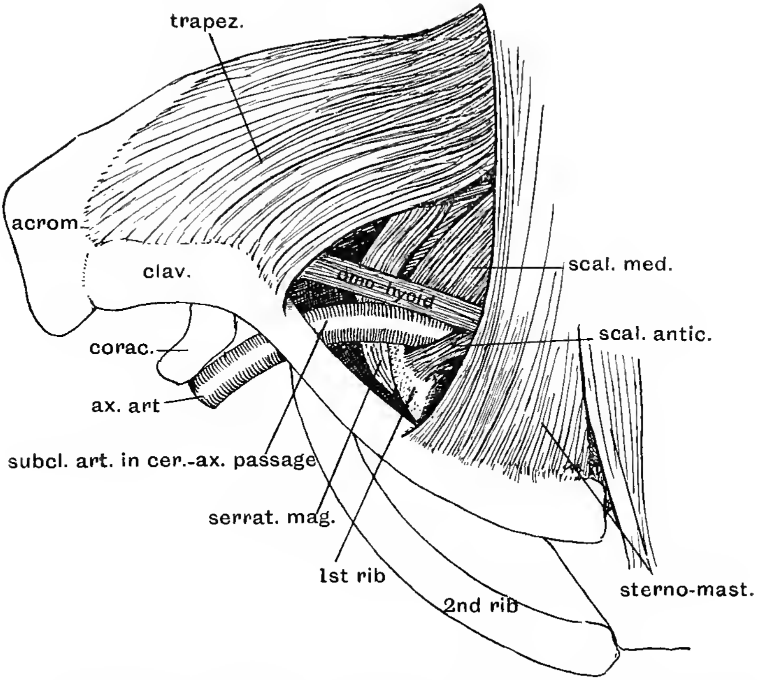
The SUPRA-SCAPULAR NERVE enters the supra-scapular notch anterior to the insertion of the omo-hyoid. For the greater part of its course it lies in the occipital triangle and beneath the trapezius (fig. 285).

Cervico-axillary Passage (fig. 286).—The apex of the axilla projects behind the clavicle into the floor of the subclavian triangle and forms a passage by which the vessels and nerves pass from the neck to the arm (fig. 286). The manner in which this passage is formed should now be examined. In the articulated skeleton the cervico-axillary passage is a triangular interval between the clavicle in front, the first rib behind, and the upper border of the scapula to the outer side. In the recent state the subscapularis and serratus magnus help to fill the interval between the scapula and rib. Notice that the clavicle is not horizontal; its outer end is at a higher level than its inner extremity.

The *anterior boundary* of the passage is an upward continuation of the anterior wall of the axilla. It is formed by the middle third of the clavicle, the subclavius muscle, and its sheath. The remainder of the subclavius muscle is to be removed and the axillary vein followed into the subclavian.

The *inner* or *posterior boundary* is the upward continuation of the inner wall of the axilla. It is formed by the outer border of the first rib, which gives origin to the first digitation of the serratus magnus. The subclavian artery and brachial plexus pass into the axilla at the outer edge of the first rib. The subclavian vein, as it passes into the neck, lies between the clavicle and the scalenus anticus; the subclavian artery and brachial plexus emerge between the scalenus anticus and medius.

FIG. 286.—THE FLOOR OF THE SUBCLAVIAN TRIANGLE AND CERVICO-AXILLARY PASSAGE



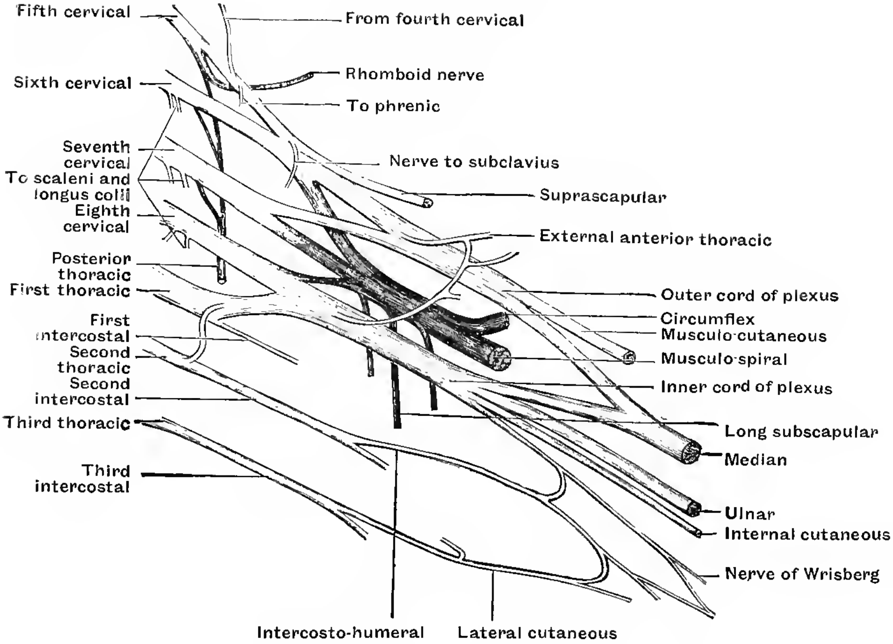
The *outer boundary* is formed by three muscles which partially fill up the interval between the first rib and scapula; they are the serratus magnus, scalenus posticus and subscapularis.

Brachial Plexus (fig. 287).—To expose it the vein and artery are divided at the outer border of the first rib, the axillary vessels being turned downwards. The plexus is surrounded by a fibrous sheath (p. 44), which requires careful dissection.

FORMATION.—The brachial plexus is formed by the anterior divisions of the fifth, sixth, seventh, eighth cervical and first dorsal nerves; besides these, contributions from the fourth cervical and second dorsal, of variable size, also enter it. Thus the brachial plexus arises from seven spinal nerves and segments of the cord, from the fourth cervical to the second dorsal.

STAGES.—There are four stages recognised in the formation of the brachial plexus: two in the neck and two in the axilla (fig. 287).

FIG. 287.—THE BRACHIAL PLEXUS. (*From Morris's 'Anatomy.'*)



In the FIRST STAGE the *spinal nerves* emerge from the intervertebral foramina and appear between the scalenus anticus and medius (Plate XLVI, p. 70). The first dorsal nerve turns obliquely upwards (fig. 301, p. 89) in front of the neck of the first rib, the fasciculus from the second dorsal nerve joining the first.

In the SECOND STAGE the spinal nerves form three *trunks* as they emerge above the first rib. The upper trunk is formed by the union of the fifth and sixth cervical; the seventh forms the middle trunk; both of these lie above the subclavian artery, and in thin subjects can be felt at the posterior border of the sterno-mastoid passing downwards into the subclavian triangle. The lower trunk is formed by the eighth cervical and first dorsal nerves; it lies behind the third stage of the subclavian artery.

The THIRD STAGE is formed as the trunks enter the axilla by each trunk splitting into two divisions; six *divisions* in all being formed, three anterior and three posterior.

The FOURTH STAGE lies in the axilla and surrounds the axillary artery; the divisions unite to form *cords*. The three posterior divisions unite to form the posterior cord behind the artery; the upper two divisions unite to form the outer cord, on the outer side of the axillary artery; the remaining anterior division forms the inner cord, on the inner side of the artery.

The cords of the brachial plexus are tied together, divided, and turned down in the arm.

Branches of the Brachial Plexus in the neck (fig. 287).—These are now to be dissected out. They are:

(1) Nerve to the subclavius.
(2) Twigs to the phrenic.
(3) The suprascapular nerve.
(4) The posterior thoracic nerve.
(5) The nerve for the rhomboids.
(6) Muscular branches to the scalene and prevertebral muscles.

(1) NERVE TO THE SUBCLAVIUS. This has been already traced from the fifth cervical (fig. 285, p. 47).

(2) A TWIG TO THE PHRENIC NERVE from the fifth cervical, or from the nerve to the subclavius, or both.

(3) SUPRA-SCAPULAR NERVE. It is a large nerve and arises from the upper trunk of the brachial plexus. It passes outwards beneath the posterior belly of the omo-hyoid and enters the supra-scapular notch under the transverse scapular ligament. It supplies the supra-spinatus, infra-spinatus, and shoulder-joint.

(4) NERVE TO THE SERRATUS MAGNUS (posterior thoracic or nerve of Bell). It will be found as it perforates the scalenus medius. It arises from the fifth, sixth, and seventh cervical nerves. From the scalenus medius, it passes direct to the serratus magnus, behind the first stage of the axillary artery.

Its distribution to the muscle is seen on the inner wall of the axilla.

(5) The Nerve for the Rhomboids has been already traced; it rises from the fifth cervical and perforates the scalenus medius above the nerve to the serratus magnus.

(6) Muscular Branches to the scalene and longus colli muscles. The dissectors of the upper extremity now remove their part.

DISSECTION V

THE ANTERIOR TRIANGLE OF THE NECK

The Anterior Triangle (see fig. 280, p. 35) of the neck is subdivided by the anterior belly of the omo-hyoid, and by both bellies of the digastric into:—

(1) INFERIOR CAROTID TRIANGLE.

(2) SUPERIOR CAROTID TRIANGLE.

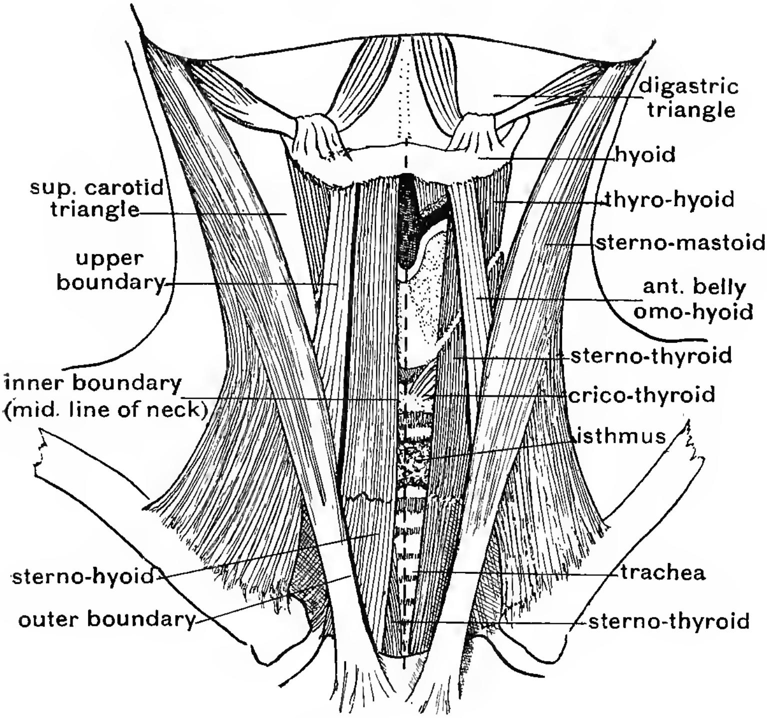
(3) DIGASTRIC OR SUBMAXILLARY TRIANGLE.

Inferior Carotid Triangle.—The right and left inferior carotid triangles must be dissected together, as they form one space containing, amongst other structures, the cervical stages of the trachea and œsophagus. In this combined space the operations of tracheotomy, laryngotomy, and œsophagotomy are performed, and it is therefore a space requiring particular attention.

Boundaries.—The boundaries of the two inferior carotid triangles are to be defined (fig. 288).

Mesial Boundary.—The middle line of the neck, from the body of the hyoid bone above to the supra-sternal notch below, separates the right triangle from the left. In this line operations on the trachea and larynx are performed. Above, the body of the hyoid is felt; below it, the thyro-hyoid space and membrane, with the notch and prominent anterior angle of the thyroid cartilage. Between the thyroid and cricoid cartilagee (fig. 289), the crico-thyroid space, filled by the crico-thyroid membrane, is big enough to take the tip of the fore-finger. Below the cricoid eight or ten rings of the trachea are felt, deeply placed in the neck, for the trachea recedes from the surface as it descends (fig. 283, p. 44). Two inches of the trachea lie in the neck of the adult, but by extending the head backwards another inch may be brought above the suprasternal notch; in the young child the extent of the trachea available for operation is little more than one inch. Along the middle line there are two layers of the deep cervical fascia superficial to the trachea, but they are separated only at the upper border of the sternum (fig. 283).

Fig. 288.—The boundaries and muscles in the roof of the two inferior carotid triangles.



The *upper boundary*, formed by the anterior belly of the omo-hyoid, is to be defined. The muscle crosses the lateral lobe of the thyroid body and passes under the anterior border of the sterno-mastoid, two and a half inches above the sternum (fig. 288).

The *outer boundary* is formed by the anterior border of the sterno-mastoid (lower two and a half inches).

Roof.—The skin, superficial fascia, fascial roof of the anterior triangle, and sterno-hyoid, sterno-thyroid, and omohyoid muscles, with their sheaths (fig. 290), form the coverings of the inferior carotid triangle.

Sterno-hyoid (fig. 288). Origin.—From the posterior aspect of the manubrium sterni and the posterior sternoclavicular ligament. The two muscles are separated at their origin by a space half an inch in width. A tendinous intersection is frequently seen in them at or a little above the level of the upper border of the sternum.

Insertion.—The muscles converge and are inserted by tendinous fibres to the lower border of the body of the hyoid.

Nerve Supply.—Ansa hypoglossi, the nerve fibres of which are derived from the first, second, and third cervical nerves (see fig. 291).

Action.—They may fix the hyoid bone to the sternum. They depress the hyoid bone, and, through the muscles attached to the hyoid, the lower jaw and tongue.

Sterno-thyroid (fig. 288).—The sterno-hyoid is detached at its origin and insertion. Beneath it the sterno-thyroid is seen, passing upwards and outwards. Between the sterno-hyoid and sterno-thyroid of one side and those of the other, a narrow diamond-shaped space is left in front of the trachea (fig. 288).

Origin.—From the posterior aspect of the manubrium sterni, from the cartilage of the first rib, its origins being lower down and behind that of the sterno-hyoid. The origins of the two sterno-thyroids are close together; they diverge to each side of the trachea as they ascend. They cover the muscular surface of the lateral lobes of the thyroid gland.

Insertion.—To the oblique line on the thyroid cartilage (fig. 401, p. 250).

Nerve Supply. Ansa hypoglossi (fig. 291).

Action.—It depresses the larynx.

Thyro-hyoid (fig. 288). This is really a continuation of the sterno-thyroid muscle to the hyoid bone. It lies beneath the hyoid insertion of the omo-hyoid; it lies partly within the inferior, and partly within the superior carotid triangle.

Origin.—From the oblique line of the thyroid cartilage at the insertion of the sterno-thyroid (fig. 288).

Insertion. To the lower border of the body of the hyoid (outer half) and great horn (inner half).

Nerve Supply.—A twig will be found passing beneath its posterior border. It comes from the hypoglossal nerve (fig. 292).

Action.—If the hyoid bone be fixed, it raises the larynx under the hyoid bone, as in swallowing; if the thyroid cartilage be fixed by the sterno-thyroid, it depresses the hyoid bone and tongue.

Omo-hyoid (figs. 285, 288). Origin.—By tendinous fibres from the lower border of the body of the hyoid outside the sterno-hyoid insertion.

It covers the lateral lobe of the thyroid gland and disappears beneath the anterior border of the sterno-mastoid.

Insertion.—To the upper border of the scapula, behind the supra-scapular notch.

Beneath the posterior part of the sterno-mastoid is an *intermediate tendon*, corresponding to the intersection found in the infra-hyoid group of muscles at the level of the upper border of the sternum. The tendon lies in a loop of fascia by which it is bound to the clavicle and first rib. The anterior and posterior bellies meet in the intermediate tendon at an angle. The posterior belly divides the posterior triangle into the subclavian and occipital triangles. The anterior belly lies beneath the sterno-mastoid in part; in front of the sterno-mastoid it separates the superior and inferior carotid triangles.

Nerve Supply.—The ansa hypoglossi (fig. 291).

Action.—It depresses and pulls the larynx and pharynx backwards. If the hyoid is fixed, it may help to elevate and pull the shoulder forwards.

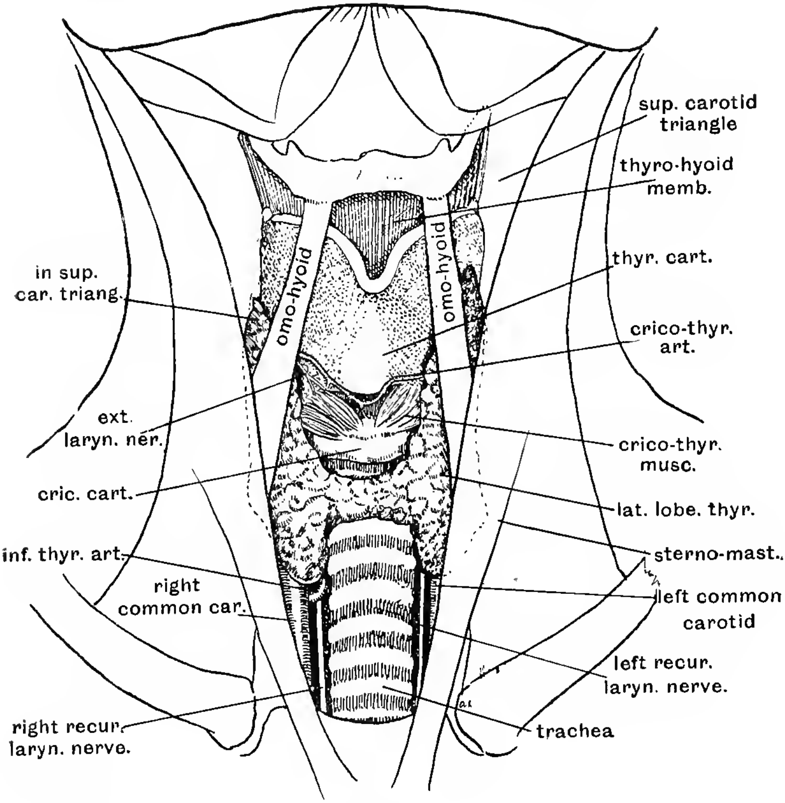
Contents of the Inferior Carotid Triangles.—The sterno-thyroid muscles are removed, and the structures seen within the inferior carotid triangles examined. Although this triangle is called carotid, the common carotid vessels do not lie in it. They pass upwards beneath the sterno-mastoid, in the sterno-mastoid space. But when the deep cervical fascia, which unites the sheaths of the sterno-mastoids together in front of the neck, is dissected away, these muscles shift backwards and outwards and expose the common carotid arteries at their anterior borders. To tie the common carotid artery, the surgeon makes an incision along the posterior boundary of the inferior carotid triangle. The contents of the two triangles in the natural condition of parts are :—

(1) The ISTHMUS and greater part of each of the LATERAL LOBES of the thyroid body.

(2) The INFERIOR THYROID VEINS descending in front of the trachea.

(3) The INFERIOR THYROID ARTERIES (figs. 289, 290). They are deep, and pass to the lower poles of the lateral lobes beneath the carotid sheath. They rise from the thyroid axis (Plate XLVI, p. 70).

FIG. 289.—THE CHIEF CONTENTS OF THE INFERIOR CAROTID TRIANGLES.



(4) The CERVICAL STAGE OF THE TRACHEA (fig. 289 and Plate XLVI, p. 70).

(5) The CERVICAL STAGE OF THE ŒSOPHAGUS behind the trachea. It deviates to the left, and its edge is seen behind that side of the trachea (figs. 289 and 290). It is in this stage

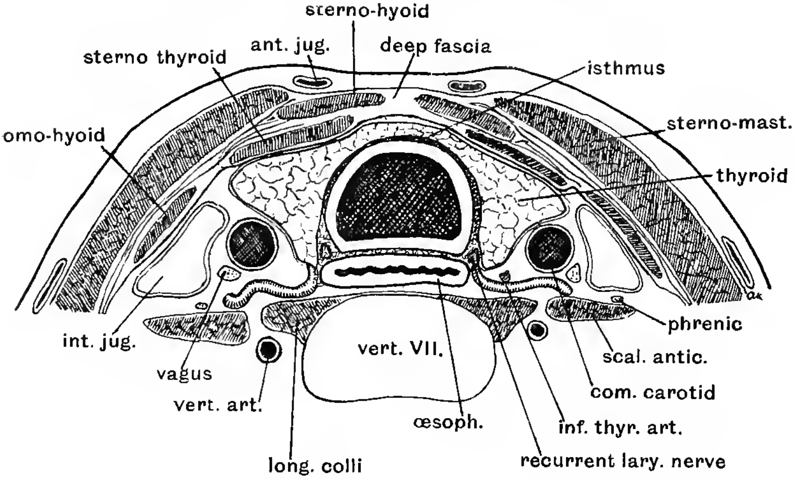
that the surgeon operates on the œsophagus. The cervical stage is about one and a half or two inches long.

(6) The Recurrent Laryngeal Nerves ascend in the angle between the trachea and œsophagus on each side (figs. 289 and 290).

(7) The Cricoid Cartilage, the Crico-thyroid Space, the Crico-thyroid Muscle, Artery and Nerve, and the anterior angle of the Thyroid Cartilage lie in the space (fig. 289).

(8) The inner margins of the Carotid Sheaths and common carotid arteries (figs. 289 and 290).

Fig. 290.—Section of the neck showing the relative position of the main contents of the inferior carotid triangles.



(9) Occasionally a thyroid artery (Thyroidea ima) arises on the right side from the innominate artery. It ascends in front of the trachea. The left innominate vein may also appear within the triangles, above the level of the sternum, especially in conditions in which it is distended.

The sternal origins of the sterno-mastoids lie in front of the margins of the trachea and form the lateral boundaries of the supra-sternal fossa.

Superior Carotid Triangle. Boundaries.—These are now to be defined (fig. 291) :—

(1) The *posterior boundary* formed by the upper two-thirds of the anterior border of the sterno-mastoid; (2) the *anterior*

inferior boundary by the anterior belly of the omo-hyoid ; (3) the *upper boundary* by the posterior belly of the digastric.

ROOF.—The roof formed by the skin, subcutaneous tissue, platysma and deep cervical fascia, has been already removed. In the roof lay branches of the superficial cervical and facial nerves and the anterior jugular vein.

CONTENTS OF THE SUPERIOR CAROTID TRIANGLE

The structures lying within the superior carotid triangle are now to be dissected out one by one and examined in the order in which they are dealt with in the succeeding pages (fig. 291).

(1) The **upper set of deep cervical glands.**—These have been already examined. One or two large glands over the carotid sheath, behind the angle of the jaw, receive the lymph from the tonsil and fauces, and hence enlarge in any affection of the throat.

(2) The **Hypoglossal** is the motor nerve of the tongue and the twelfth of the cranial series. In its course from the medulla oblongata to the tongue it passes through the superior carotid triangle (*carotid stage*). It emerges from the SUB-PAROTID SPACE (fig. 291) and passes to the submaxillary space. It will be found hooking round the origin of the occipital artery from the external carotid (fig. 291), just under the posterior belly of the digastric and parotid gland. It passes forwards in the upper part of the triangle, crossing the external carotid and the loop of the lingual artery, and then coming to rest on the hyoglossus muscle (fig. 291). On this muscle it passes under the posterior belly of the digastric and enters the submaxillary space. It gives off two branches in the triangle:

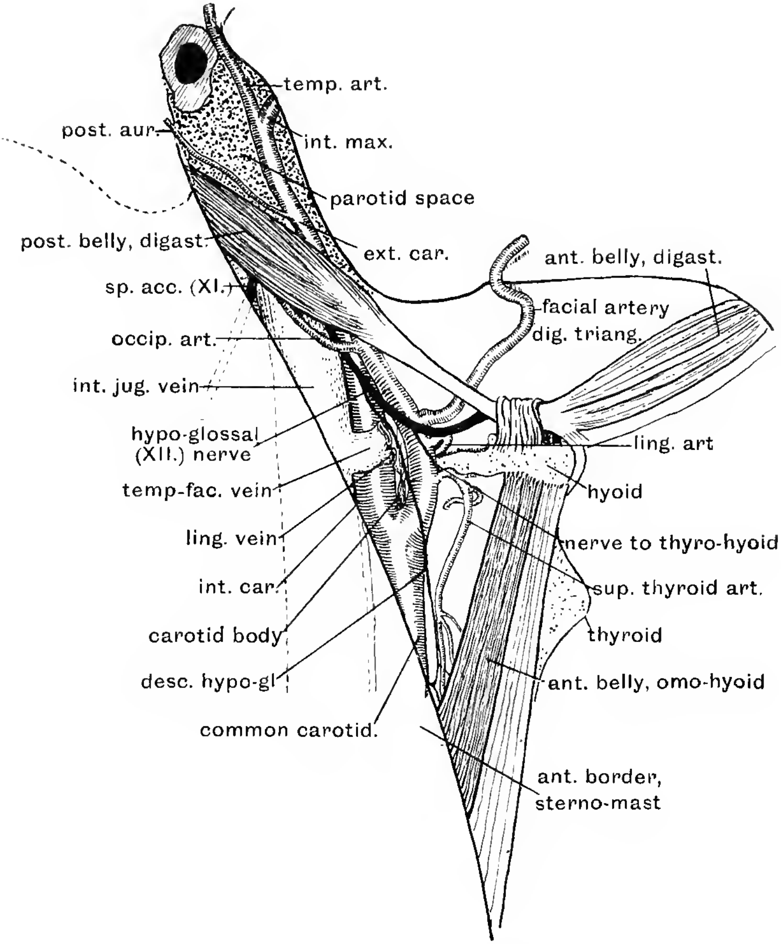
(*a*) The DESCENDENS HYPOGLOSSI (fig. 291), which arises as the nerve enters the triangle and descends in front of the carotid sheath, imbedded in the fibrous tissue.

(*b*) The NERVE TO THE THYRO-HYOID muscle (fig. 292). It arises as the hypoglossal crosses the external carotid and passes to the posterior border of its muscle.

(3) **Ansa Cervicalis** (fig. 295).—This is a loop formed by the nerves which supply the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles. It is formed by the union of the descendens hypoglossi from the hypoglossal nerve (fig. 295) and the communicans cervicalis from the second and third cervical

nerves. The descendens hypoglossi has been already found passing down in the carotid sheath. When followed downwards, its union with the cervical branch is found over and to the outer side of the carotid sheath. From the convexity of the loop branches pass to the infra-hyoid group of muscles, each belly of the omo-hyoid having a separate nerve.

Fig. 291.—The boundaries and chief contents of the superior carotid triangle.



(4) The **Spinal Accessory (XI) Nerve**, in its course from the spinal cord and medulla to the sterno-mastoid and trapezius,

crosses the upper angle of the superior carotid triangle (superior carotid stage) (fig. 291). It emerges beneath the posterior belly of the digastric and almost immediately passes under the sternomastoid at a point one and a half inches below the mastoid process. Some of the upper deep cervical glands lie round it.

(5) **Bifurcation of the Common Carotid Artery.**—The common carotid artery bifurcates at the level of the thyrohyoid space. Hence, within the superior carotid triangle lie the following arterial trunks :

(A) The termination of the common carotid; (B) the commencement of the internal carotid; (C) the commencement of the external carotid.

The strong, fibrous carotid sheath is to be removed from these arterial trunks.

(A) The **Common Carotid Artery** lies partly under cover of the lateral lobe of the thyroid body (being overlapped by the carotid surface of that body) ; the internal jugular vein is at its outer side; the temporo-facial, lingual, upper and middle thyroid veins cross the artery to reach the internal jugular (fig. 291). The vagus lies deep to the artery and internal jugular vein, its laryngeal branches passing inwards deep to the artery.

(B) The **Internal Carotid** (fig. 291) is the direct continuation of the common carotid. It lies behind and somewhat to the outer side of the commencement of the external carotid. About an inch of its course lies in this triangle; it then enters the sub-parotid space (fig. 292). It gives off no branches.

(C) The **External Carotid** artery (fig. 292) makes a bend forwards and inwards at its commencement. Then, after a course of little more than an inch, it disappears beneath the posterior belly of the digastric and enters the parotid space.

In this stage the external carotid gives off the following five branches :

(*a*) Superior Thyroid Artery.
(*b*) Lingual Artery.
(*c*) Facial Artery.
(*d*) Occipital Artery.
(*e*) Ascending Pharyngeal.

Only one of these, the superior thyroid, is distributed within the triangle. The lingual, which loops above the posterior end of the great horn of the hyoid, passes on the side of the tongue beneath the hyoglossus muscle (fig. 291). The facial disappears almost immediately under the posterior belly of the digastric and enters the submaxillary space. The occipital passes backwards beneath the lower border of the posterior belly of the digastric, and reaches the occipital region by a course situated beneath the mastoid process and the muscles attached to it. The ascending pharyngeal arises from the deep surface of the external carotid and enters the sub-parotid space where it is distributed. The facial and lingual arteries sometimes arise together.

(6) The **Superior Thyroid Artery** (fig. 291).—It is the first branch of the external carotid. Looping downwards behind the thyro-hyoid muscle and under the omo-hyoid, it ends in a number of branches, which furnish the thyroid body with a rich supply of blood. The branches end on the upper poles of the lateral lobes, and are distributed on their anterior and inner surfaces as far as the isthmus, which they also supply. The arteries of the opposite sides communicate on the isthmus.

BRANCHES.—It supplies the following branches (besides numerous *muscular* branches to the sterno-mastoid and surrounding muscles):

(*a*) The *infra-hyoid*, along the lower border of the great horn of the hyoid. (*b*) The *superior laryngeal*, which enters the larynx with the superior or internal laryngeal nerve. The artery perforates the thyro-hyoid membrane and is distributed to the muscles and mucous membrane of the larynx. (*c*) The *crico-thyroid artery*, which supplies the structures in the crico-thyroid space and anastomoses with the artery of the opposite side.

(7) **Internal Jugular Vein.**—The internal jugular vein lies within a compartment of the carotid sheath, to the outer side of the common and internal carotid arteries. It emerges from the sub-parotid space (figs. 291, 292), and enters the superior carotid triangle beneath the posterior belly of the digastric. The spinal accessory nerve passes backwards superficially as the vein enters the triangle. At first the vein lies partly under the anterior border of the sterno-mastoid, and as it descends gradually passes completely beneath the muscle.

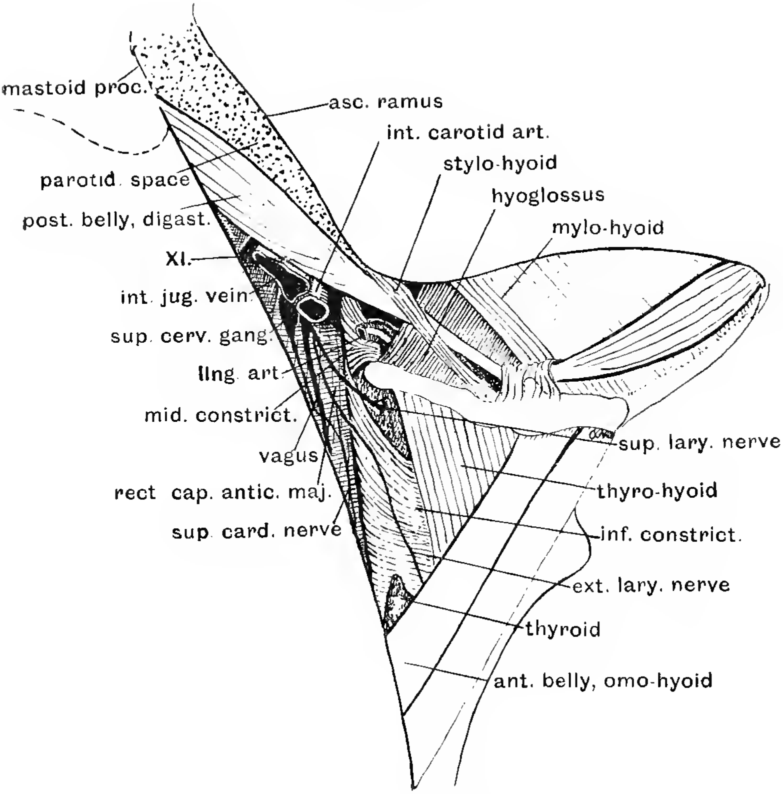
TRIBUTARIES.—In this stage of its course (superior carotid) the internal jugular vein receives the following tributaries:

(*a*) The *temporo-facial vein*, which is formed by the union of the facial with the anterior temporo-maxillary vein. The trunk thus formed crosses the bifurcation of the common carotid artery and enters the jugular vein.

(*b*) The *lingual* vein, which may enter the temporo-facial trunk or proceed separately to the internal jugular.

(*c*) The *superior and middle* thyroid veins, which spring from a plexus formed on the thyroid body. They cross outwards on the common carotid artery, and enter the jugular vein beneath the sterno-mastoid.

FIG. 292.—THE NERVES AND MUSCLES ON THE FLOOR OF THE SUPERIOR CAROTID TRIANGLE.



(*d*) Veins from the pharyngeal plexus.

(8) **Vagus** (X) (fig. 293).—The vagus nerve lies in a compartment of the carotid sheath, deep to the common carotid artery and jugular vein. It leaves the sub-parotid space and enters the superior carotid triangle with the internal jugular vein and internal carotid artery. It passes downwards in the

carotid sheath, and enters the thorax in front of the subclavian artery on the right side, and between the carotid and subclavian arteries on the left.

(9) **Superior Laryngeal Nerve.**—This nerve rises in the sub-parotid space from the trunk ganglion of the vagus (figs 292, 293, 9). It enters the superior carotid triangle beneath the internal carotid artery and on the wall of the pharynx. It passes forwards on the middle constrictor of the pharynx below the lingual vessels and perforates the thyro-hyoid membrane, under the thyro-hyoid muscle to enter the larynx. It is the sensory nerve of the larynx.

(10) **External Laryngeal Nerve.**—This small branch of the superior laryngeal is somewhat difficult to find (fig. 292). It rises from the superior laryngeal, beneath the internal carotid artery. It should be looked for as it passes beneath the insertion of the sterno-thyroid muscle, to reach the small crico-thyroid muscle, of which it is the motor nerve.

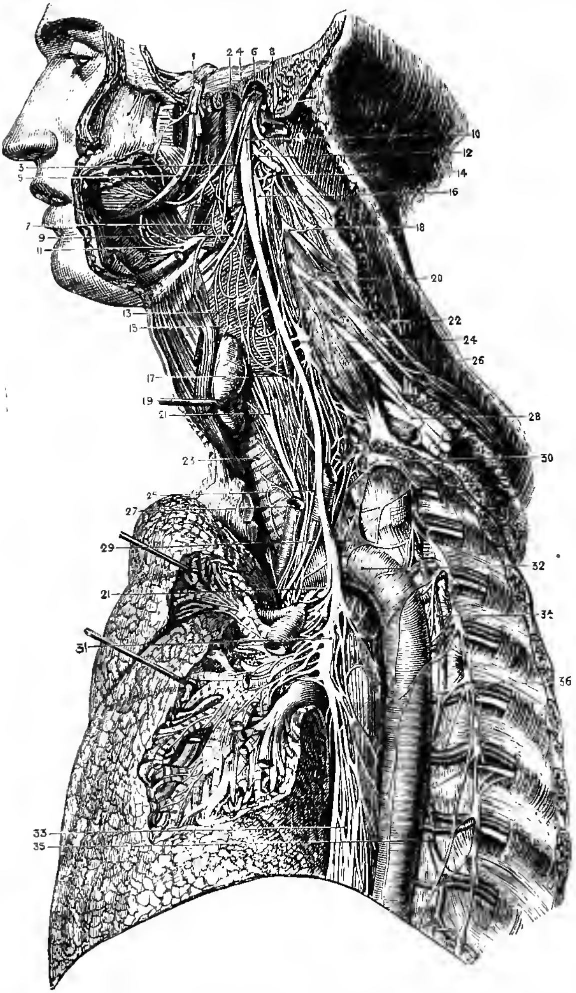
(11) **Cardiac Branches of the Vagus** (fig. 293, 15, 17).—In the superior carotid triangle, communicating fasciculi of nerve fibres will be observed to leave the laryngeal nerves (superior and external). They unite to form the superior cardiac branch of the vagus. Twigs from the superior cardiac branch of the sympathetic cord usually join with them.

(12) **Parts of the Sympathetic System.**—The superior cervical ganglion lies chiefly in the sub-parotid space (figs. 292, 369, p. 196), but its lower end appears behind the carotid sheath in the superior carotid triangle. From its lower end the sympathetic cord will be seen to proceed downwards behind the sheath (figs. 292 and 293, 16).

From the lower end of the superior cervical ganglion a stream of sympathetic nerves proceeds to the bifurcation of the carotid artery. On the inner aspect of the bifurcation, the CAROTID BODY will be found, in which some of the nerves end (fig. 291). The carotid body to the naked eye appears as a small spindle-shaped mass of reddish fibrous tissue tightly wedged in the bifurcation. Microscopically it is seen to contain a plexus of capillary vessels with polygonal cells in the vascular meshwork, and is probably nervous in nature.

The nerves which reach the external carotid artery from the superior cervical ganglion (fig. 294) form plexuses on the branches of that vessel. A plexus passes on the superior

FIG. 293.—THE CRANIAL AND CERVICAL NERVES. (*Hirschfeld and Leveillé.*)



1. Gasserian ganglion of fifth nerve. 2. Internal carotid artery. 3. Pharyngeal branch of pneumogastric. 4. Glosso-pharyngeal nerve. 5. Lingual nerve (fifth). 6. Spinal accessory nerve. 7. Middle constrictor of pharynx. 8. Internal jugular vein (cut). 9. Superior laryngeal nerve. 10. Ganglion of trunk of pneumogastric nerve. 11. Hypoglossal nerve on hyoglossus. 12. Ditto communicating with vagus and first cervical nerve. 13. External laryngeal nerve. 14. Second cervical nerve looping with first. 15. Pharyngeal plexus on inferior constrictor. 16. Superior cervical ganglion of sympathetic. 17. Superior cardiac nerve of pneumogastric. 18. Third cervical nerve. 19. Thyroid body. 20. Fourth cervical nerve. 21, 21. Left recurrent laryngeal nerve. 22. Spinal accessory communicating with cervical nerves. 23. Trachea. 24. Middle cervical ganglion of sympathetic. 25. Middle cardiac nerve of pneumogastric. 26. Phrenic nerve (cut). 27. Left carotid artery. 28. Brachial plexus. 29. Phrenic nerve (cut). 30. Inferior cervical ganglion of sympathetic united with 1st dorsal. 31. Pulmonary plexus of pneumogastric. 32. Thoracic aorta. 33. Œsophageal plexus. 34. Vena azygos minor superior. 35. Vena azygos minor inferior. 36. Gangliated cord of sympathetic.

thyroid artery to the thyroid gland, another on the facial artery to the face, and one on the lingual to the tongue. These plexuses, for the greater part, are composed of vaso-motor nerves.

Floor of the Superior Carotid Triangle (fig. 292).—The structures which fill the space of the superior carotid triangle rest in a triangular interval bounded internally by the wall of the pharynx and part of the lateral wall of the larnyx. Externally or behind, the space in which the contents of the superior carotid triangle are contained is bounded by the rectus capitis anticus major (fig. 292).

Connections of the Superior Carotid Triangle with surrounding Spaces (see fig. 280, p. 35).—Above, the superior carotid triangle communicates under the posterior belly of the digastric muscle with the submaxillary space, and with the parotid and sub-parotid spaces (fig. 291). Behind and below, it is continuous, under the anterior border of the sterno-mastoid, with the sterno-mastoid space; while below and in front it is continuous, under the anterior belly of the omo-hyoid, with the inferior carotid triangle (fig. 288).

Thyroid Body or Gland.—In recent years the physiology and surgery of the thyroid body have assumed an ever-increasing degree of importance. It is one of the ductless glands and is developed, at an early fœtal stage, from the epithelium or hypoblast which lines the pharynx. It consists of two lateral lobes joined by an isthmus. The *isthmus* of the gland, which crosses the upper two or three tracheal rings, is developed from the floor of the pharynx; the foramen cæcum on the tongue marks the point at which it arose. The *lateral lobes* of the gland, which the isthmus joins together, spring as buds from each side of the pharynx; the pyriform fossæ, at each side of the opening of the larynx into the pharynx, mark the places from which the lateral lobes sprang. In health the isthmus and lateral lobes of the thyroid gland can be only obscurely palpated. The upper pole of each lateral lobe projects within the superior carotid triangle, but the greater part of the gland is situated within the inferior triangles.

The Isthmus (fig. 289, p. 58) is a flat band of thyroid tissue which unites the lower ends of the lateral lobes and lies, as a rule, over the second, third, and fourth rings of the trachea. The inner margins of the two sterno-hyoid and two sterno-thyroid muscles almost cover it.

Fibrous bands attached above to the cricoid end in the fibrous capsule of the isthmus, and especially in the adjacent parts of the lateral lobes forming the *suspensory ligaments* of the thyroid; thus the thyroid body is bound to the larynx and trachea and follows their movements. Hence, in swallowing, the thyroid body, if enlarged, can be seen to move with the larynx.

A *pyramid* of thyroid tissue is frequently found passing from the isthmus towards the hyoid bone, to which it has a fibrous attachment. With the pyramid of the thyroid, there is usually present a detached slip of the sterno-hyoid (levator glandulæ thyroideæ), which is attached to the hyoid above and ends below on the pyramid and isthmus of the thyroid gland.

LATERAL LOBES.—Each lateral lobe ends above at an upper pole near the oblique line of the thyroid cartilage, and below at a thicker rounded pole opposite the fifth or sixth tracheal ring. Each lobe has three well-marked surfaces, an anterior or muscular surface, an outer or carotid, and an inner or laryngeal (figs. 289 and 290).

SURFACES AND RELATIONSHIPS OF THE LATERAL LOBES (fig. 290).

(1) The *anterior* or *muscular* surface is covered by the sterno-thyroid, sterno-hyoid, omo-hyoid, and anterior border of the sterno-mastoid.

(2) The *outer* or *carotid* surface is in contact with the carotid sheath, which it overlaps to some extent.

(3) The *inner* or *laryngeal* surface is in contact with (*a*) the trachea, (*b*) the recurrent laryngeal nerve, (*c*) the œsophagus, (*d*) the cricoid cartilage, (*e*) part of the thyroid cartilage and origin of the inferior constrictor of the pharynx, (*f*) the external laryngeal nerve.

The *posterior border*, between the inner and outer surfaces, is sharp and prominent, and below rests against the œsophagus.

STRUCTURE.—Very little can be learned from the naked-eye anatomy of the gland. Some of the acini may be seen dilated into small cysts containing colloid material. The substance of the gland is dark red. The capsule is composed of loose tissue in which the veins ramify.

Blood Supply.—Two arteries reach it on each side, making four arteries in all; sometimes there is a fifth, the thyroidea ima.

The *superior thyroid*, a branch of the external carotid, ends on each side in the upper and anterior part of the gland and isthmus; the *inferior thyroid*, a branch of the thyroid axis from the first stage of the subclavian artery, supplies the lower and posterior aspect of the gland on each side. The blood supply is thus seen to be very rich. The THYROIDEA IMA, if present, commonly arises from the innominate artery.

Three pairs of veins drain the thyroid. They rise from the venous plexus in the capsule. The superior and middle thyroid veins cross the common carotid artery and end in the internal jugular. The inferior thyroid veins form a plexus in the loose tissue which lies over the trachea, and pass within the thorax to end in the innominate veins.

LYMPHATICS.—The lymphatic vessels enter lymph glands by the side of the trachea and œsophagus. Some also pass with the superior thyroid veins to the upper deep cervical glands.

NERVES.—Nerves reach it on the arteries. They come from the superior and middle cervical ganglia.

PARA-THYROID BODIES.—The thyroid body should be carefully detached and the fibrous bands which fix it to the cricoid observed. Care must be taken not to cut away the recurrent laryngeal nerves. When the tracheal and outer aspects of the gland are examined, one or two small bodies may be seen imbedded on the surface among the terminal branches of the inferior thyroid artery. These are the para-thyroids, about the size of orange seeds and brownish-red in colour. Accessory or detached pieces of the thyroid gland resemble them, but are of a darker tint. Only microscopic examination can differentiate between para-thyroid and accessory thyroid bodies. The parathyroids are most easily found in the newly born.

DISSECTION VI

THE STERNO-MASTOID AND THE STRUCTURES BENEATH IT

The dissection of this region finishes the examination of the neck. The carotid triangles and their contents in front of the sterno-mastoid, and the posterior triangle and its contents behind this muscle, have now been examined.

The Sterno-mastoid as a Surface-mark.—Under all conditions the clinician or surgeon finds the sterno-mastoid a useful and reliable guide to the structures of the neck. It covers a great number of most important parts. The student cannot fail to notice its oblique position. Below, it lies in the anterior half of the neck, above, in the posterior half. The tubercles of the cervical transverse processes lie beneath it; above, they are near its anterior border; below, they are near its posterior border. In the line of the tubercles all the cervical nerves issue beneath the muscle and enter into the formation of the cervical and brachial plexuses (fig. 294, p. 71). The great blood-vessels of the upper extremity and of the head and neck lie beneath it in its lower half (Plate XLVI). It is convenient to have a name to indicate the space beneath it, seeing it contains so many important structures. Until a better is found it may be called the STERNO-MASTOID SPACE. It is further convenient to distinguish the upper and lower halves of the space. In the upper half the four cervical nerves which form the cervical plexus emerge; it may be called the upper sterno-mastoid space; in the lower, the four cervical nerves which enter the brachial plexus appear; it may be called the lower sterno-mastoid space. In the upper part of the space lie many of the superior set of deep cervical lymphatic glands; in the lower part, the inferior set of deep cervical lymphatic glands.

Sterno-mastoid.—The sheath of this muscle (fig. 282, p. 42) and its connections have been already examined and dissected away.

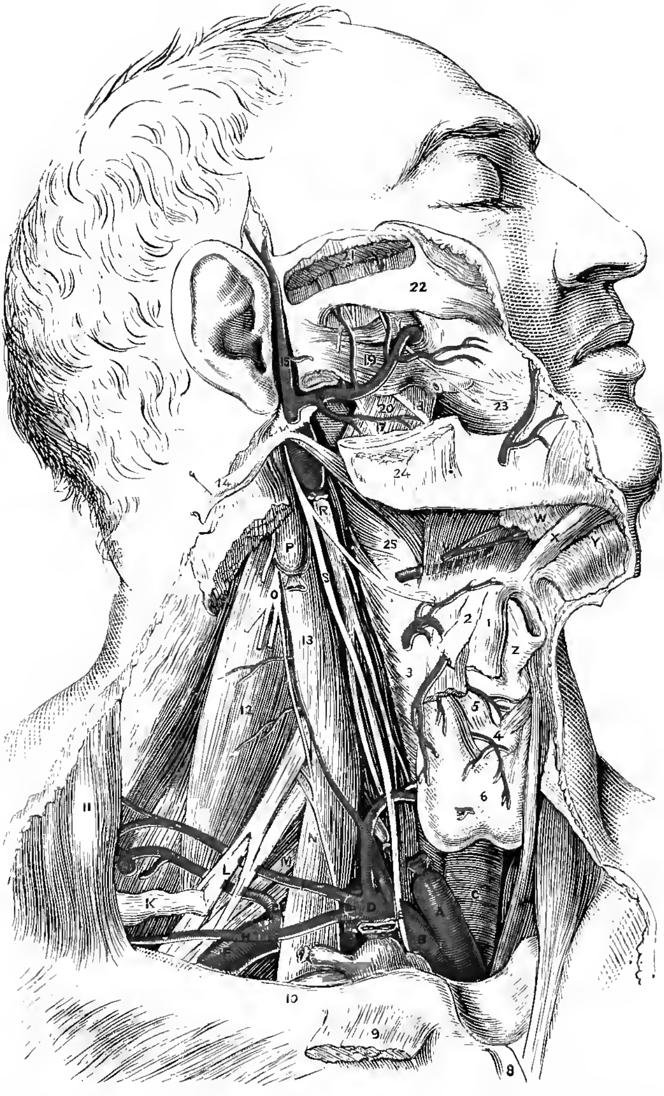
Origin.—By two heads—sternal and clavicular. They are separated by an interval above the inner end of the clavicle. The *sternal* head arises by a rounded tendon from the anterior surface of the manubrium sterni. The *clavicular* head arises by muscle fibres from the upper surface of the inner third of the clavicle.

Insertion.—The *sternal* fibres are superficial, and are inserted to (*a*) the anterior border and outer surface of the mastoid process (sterno-mastoid fibres); (*b*) the outer third of the superior curved line (sterno-occipital fibres).

The *clavicular* or *cleidal* fibres are inserted to (*a*) the outer aspect of the mastoid process under the sternal fibres and over the splenius (cleido-mastoid fibres) and (*b*) to the superior curved

PLATE XLVI

DEEP DISSECTION OF HEAD AND NECK. (*Maclise.*)

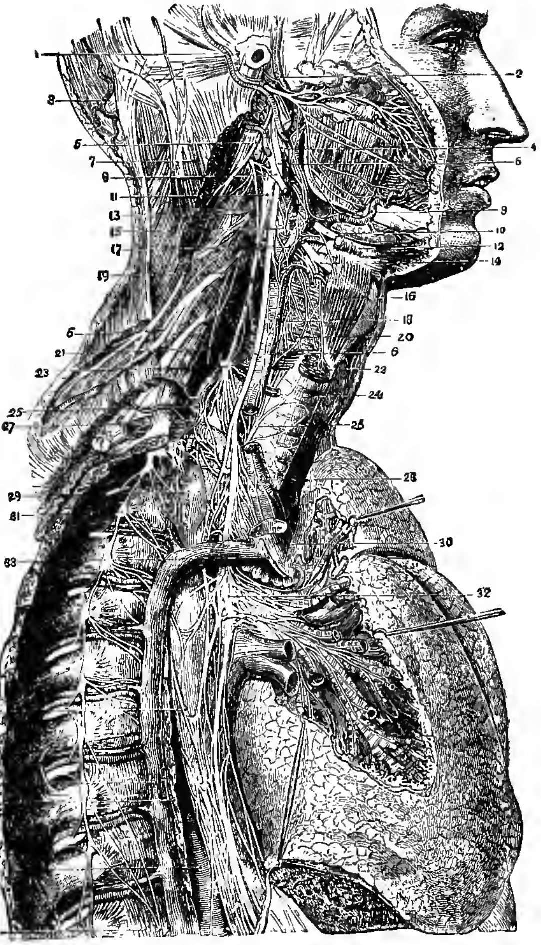


A. Right common carotid (cut). B. Right subclavian. C. Trachea. D. Thyroid axis. E. Vagus nerve, crossing subclavian artery. F. Subclavian artery, third part. G. Posterior scapular artery, arising from third part of subclavian. H. Supra-scapular artery. I. Superficialis colli artery. K. Posterior belly of omo-hyoid. L. Median nerve, branch of brachial plexus. M. Brachial plexus. N. Scalenus anticus, with phrenic nerve lying on it. O. Cervical plexus. P. Upper part of internal jugular vein. Q. Upper part of internal carotid artery. R. Superior cervical ganglion of sympathetic. S. Upper part of vagus nerve. T. Superior thyroid artery. V. Hyo-glossus muscle covering lingual artery. W. Sublingual gland. X. Genio-hyoid muscle. Y. Mylo-hyoid muscle (turned down). Z. Thyroid cartilage. 1. Sterno-hyoid muscle. 2. Omo-hyoid muscle. 3. Inferior constrictor of pharynx. 4. Cricoid cartilage. 5. Crico-thyroid muscle. 6. Thyroid body. 7. Inferior thyroid artery. 8. Sternal origin of sterno-mastoid. 9. Clavicular origin of sterno-mastoid. 10. Clavicle. 11. Trapezius. 12. Scalenus medius. 13. Rectus capitis anticus major. 14. Stylo-hyoid muscle (turned back). 15. Temporal artery. 16. Internal maxillary artery. 17. Inferior dental nerve. 18. Lingual branch of fifth nerve. 19. External pterygoid muscle. 20. Internal pterygoid muscle. 21. Temporal muscle (cut). 22. Zygomatic arch. 23. Buccinator. 24. Masseter. 25. Middle con-

line of the occipital bone (cleido-occipital fibres). The last set of fibres may be absent.

Nerve Supply.—From the spinal accessory (fig. 294),

Fig. 294.—The nerves beneath the sterno-mastoid. (*Hirschfeld and Leveillé.*)



1. Posterior auricular artery. 2. Temporal artery. 3. Occipital artery. 4. Glosso-pharyngeal nerve. 5, 5. Spinal accessory nerve. 6, 6. Pneumo-gastric nerve. 7. Sterno-mastoid (cut). 8. Facial artery. 9. Hypoglossal nerve with communication from 2nd cervical nerve. 10. Lower end of ditto. 11. Superior cervical ganglion of sympathetic. 12. Digastricus. 13. Third cervical nerve. 14. Superior laryngeal nerve. 15. Internal carotid. 16. Thyrohyoideus. 17. External carotid. 18 Common carotid. 19. Fourth cervical nerve. 20. Inferior constrictor of pharynx. 21. Phrenic nerve on scalenus anticus. 22. Crico-thyroideus. 23. Middle cervical ganglion. 24. Trachea. 25. Thyroid axis. 26. Recurrent laryngeal nerve. 27. Subclavian artery. 28. Innominate artery. 29. Œsophagus. 30. Vena cava superior (cut). 31. Gangliated cord of sympathetic. 32. Posterior pulmonary plexus. 33. Phrenic nerve (cut). 35. Œsophageal plexus. 37. Vena azygos major. 39 Thoracic duct. 41. Thoracic aorta. 43. Great splanchnic nerve.

which perforates the clavicular fibres of the muscle, and a branch from the second and third cervical nerves, which joins the spinal accessory.

ACTION.—If one muscle acts, the right for instance, it flexes and rotates the head so that the right ear comes towards the sternum. Both muscles acting together bend the head and neck forwards. The right sterno-mastoid, in rotating the head, acts with the left splenius; the left sterno-mastoid with the right splenius.

BLOOD SUPPLY.—Arteries pass to it from the occipital, superior thyroid and supra-scapular.

Contents of the Sterno-Mastoid Space.—The sterno-mastoid is now to be raised at its origin and insertion and completely removed, care being taken to leave the spinal accessory nerve in position. The insertions of the splenius and trachelo-mastoid to the mastoid process are also cleaned away (Plate XLIV, p. 14). The contents of the space are now to be examined. They are classified in the following list:

(1) NERVES (figs. 293 and 294).

(*a*) The anterior divisions of the eight cervical nerves. The upper four form the cervical plexus, the lower four pass to the brachial plexus.

(*b*) The spinal accessory nerve.

(*c*) Vagus.

(*d*) The middle and lower cervical ganglia of the sympathetic. The upper is included in the contents of the superior carotid triangle; it lies beneath the anterior border of the muscle.

(2) ARTERIES.

(*a*) The first two stages of the subclavian artery, and branches from these two stages (Plate XLVI, p. 70).

(*b*) The common carotid artery (in the lower half of the sterno-mastoid space).

(*c*) The occipital artery.

(3) VEINS (fig. 291).

(*a*) The internal jugular for the greater part of its extent.

(*b*) The greater part of the subclavian vein (fig. 285, p. 47).

(*c*) The union of the internal jugular and subclavian to form the innominate vein. The termination of the anterior jugular vein.

(4) LYMPHATICS.

(*a*) The upper and lower groups of the deep cervical glands.
(*b*) The termination of the thoracic duct on the left side.
(*c*) The right lymphatic duct on the right.

MUSCLES BENEATH THE STERNO-MASTOID.—As the transverse processes of the cervical vertebræ, from the first to the seventh, lie beneath the sterno-mastoid, the muscles attached to the anterior or posterior tubercles of these processes, at their origins or insertions, also lie beneath the sterno-mastoid and form a floor for the space. To the anterior tubercles are attached the following muscles: the scalenus anticus (lying entirely beneath the sterno-mastoid), the longus colli, rectus capitis anticus major and rectus capitis lateralis. To the posterior tubercles are attached: the splenius colli, levator anguli scapulæ, scalenus medius and posticus. The splenius capitis is inserted to the mastoid process beneath the sterno-mastoid (Plate XLIV, p. 14); the posterior belly of the digastric appears beneath the anterior border of the sterno-mastoid above; the anterior belly of the omo-hyoid passes beneath, at the junction of the middle and lower thirds of the anterior border of the sterno-mastoid (fig. 288).

Behind its lower part lie also the apex of the lung and posterior part of the first rib. The contents of the sterno-mastoid space are now to be examined in detail.

Cervical Plexus.—The anterior divisions of the first, second, third and fourth cervical nerves unite together and form the cervical plexus (fig. 295). The third and fourth nerves are by far the larger; they appear on the grooves of the transverse processes of the third and fourth vertebræ. The second is small, and comes out above the transverse process of the axis, at the outer border of the rectus capitis anticus major. The first cervical nerve appears in the sub-parotid space above the transverse process of the atlas, and will be examined in more detail later. A twig which joins the second will be seen. Distinct loops are formed between the second and third nerves and between the third and fourth.

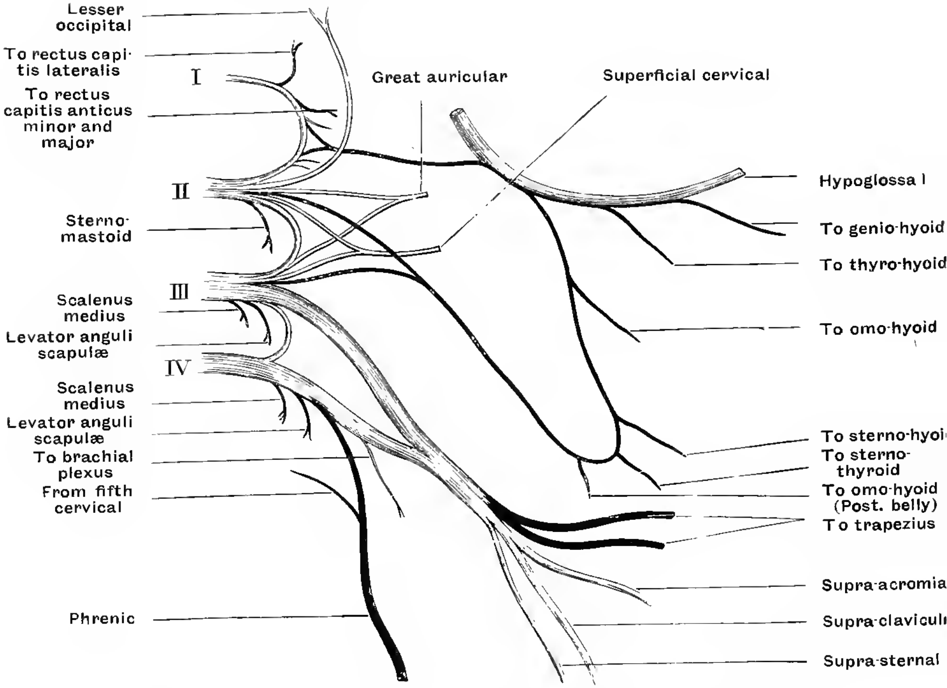
BRANCHES. (1) *Cutaneous.*—From the loop between the second and third arise the small occipital, great auricular, and superficial cervical (fig. 270, p. 11). From the third and fourth arise the three descending cervical nerves, supra-sternal, supra-clavicular, and supra-acromial (see p. 39).

(2) *Muscular.*—From the first cervical and second cervical,

fibres pass by the hypoglossal nerve, to the descendens hypoglossi, and by it to the depressors of the hyoid bone (fig. 295). From the loop between the first and second nerves, the rectus capitis lateralis, rectus capitis anticus major and minor are supplied.

From the loop formed by the second and third nerves, the communicans cervicalis passes to the infra-hyoid group of muscles. From the same loop arises the nerve to the sterno-mastoid (second and third). From the loop formed by the third and fourth arise the nerves to the levator anguli scapulæ, trapezius and scalenus medius muscles (fig. 295).

IG. 295.—DIAGRAM OF THE CERVICAL PLEXUS. THE MOTOR BRANCHES ARE REPRESENTED BLACK. (*From Morris's 'Anatomy.'*)



(3) *Communicating.*—Each of the upper four cervical nerves receives a grey ramus from the superior cervical ganglion (fig. 297).

The first nerve also communicates with the vagus.

(4) The *Phrenic Nerve*, the motor nerve of the diaphragm, also arises from the cervical plexus.

Phrenic Nerve. ORIGIN (fig. 294, 21).—Its origin is from the fourth cervical, with twigs from the third and fifth. Communications between it and the nerve to the subclavius frequently exist.

COURSE.—The nerve passes downwards from its origin on the scalenus anticus and under the sterno-mastoid. It lies behind and towards the outer side of the internal jugular vein. In the lower part of the neck it crosses the inner border of the scalenus anticus and passes downwards between the subclavian vein in front and the first stage of the subclavian artery behind. It turns round the outer (sometimes inner) side of the internal mammary artery. It then enters the thorax between the pleura and the innominate vein, and lies at first in the superior mediastinum. The thoracic stage of the phrenic nerve is described on page 254, Part II. On the left side the phrenic nerve enters the thorax, behind the innominate vein, and between the left carotid and left subclavian arteries.

Spinal Accessory.—This nerve has been already traced from the sub-parotid space across the upper angle of the superior carotid triangle (fig. 291). It passes beneath the sterno-mastoid (1½ inches below the mastoid process) and emerges at the mid-point of the posterior border of that muscle. This may be distinguished as its sterno-mastoid stage. It perforates the deeper posterior (cleidal) fibres of the muscle and unites with a branch from the second and third cervical nerves, and supplies the sterno-mastoid. It crosses the occipital part of the posterior triangle of the neck (occipital stage), unites with a branch from the third and fourth cervical nerves, and ends in the trapezius muscle (p. 10, fig. 270).

Brachial Plexus.—The origin of this plexus and its branches have been already examined (p. 51).

Cervical Stages of the Vagus.—The vagus nerve has been already traced from where it leaves the sub-parotid space and enters the superior carotid triangle. It lies in the carotid sheath, behind and between the internal jugular vein and common carotid artery. It leaves the superior carotid triangle, and, with the vessels it accompanies, passes beneath the sterno-mastoid muscle, until it reaches the root of the neck, when it enters the thorax. On the RIGHT SIDE it crosses the first stage of the subclavian artery as it disappears from the sterno-mastoid space, its recurrent laryngeal branch turning round the artery. It passes behind the commencement of the right innominate vein. It then enters the superior mediastinum (fig. 294, p. 71). On the LEFT side the relationships of the nerve as it enters the superior mediastinum differ from those of the right (fig. 293, p. 66). It lies between the left carotid and subclavian arteries, and behind the left innominate vein. The left phrenic nerve crosses it from without inwards. In the superior mediastinum it passes downwards over the left side of the arch of the aorta, and its recurrent laryngeal branch turns round that vessel, or, to be more strictly accurate, the remnant of the ductus arteriosus.

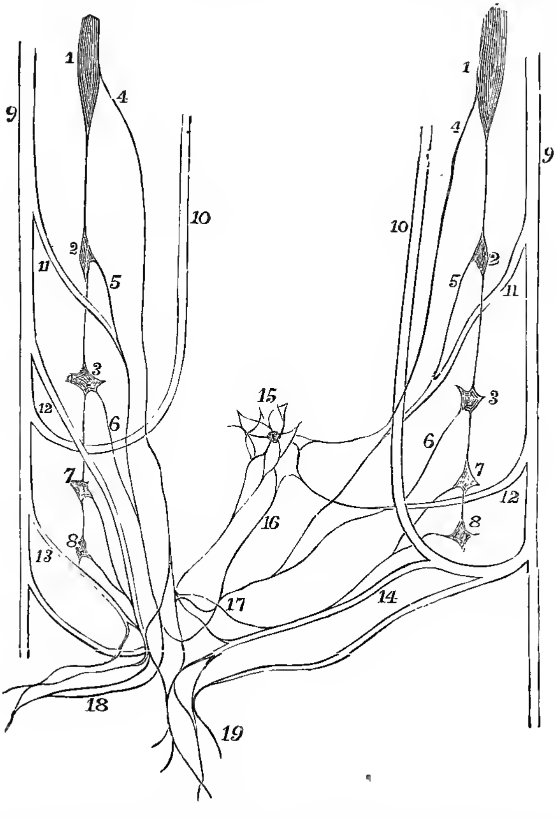
Cardiac Branches of the Vagus.—The vagus on each side of the neck gives off three cardiac branches, the upper, middle, and inferior (fig. 296). They are irregular in origin, and two or more may be combined. The upper cardiac branch arises from the vagus with the superior laryngeal nerve, or independently from the upper part of the trunk (see fig. 293, 17). The middle and inferior cardiac branches arise in the middle and lower parts of the neck (figs. 293, 294). The cardiac branches pass downwards and enter the superior mediastinum. The inferior branch on the left side passes to the superficial cardiac plexus (fig. 393, 25), all the others pass to the deep plexus.

Recurrent or Inferior Laryngeal Nerves.—These are the motor nerves of the larynx ; the only laryngeal muscles not supplied by them are the crico-thyroid. They will be found ascending in the lateral depression between the œsophagus and the trachea (fig. 293, 21). The *left nerve* arises from the vagus and turns round the arch of the aorta below the remnant of the ductus arteriosus. Hence, in aneurism of the aortic arch, the nerve is compressed and the muscles of the larynx partially paralysed. The *right nerve* turns round the first stage of the right sub-clavian artery (fig. 294, 26).

BRANCHES.—As the nerves ascend in the loose tissue, at each side of the cervical stages of the œsophagus and trachea, they give off branches to (1) the deep cardiac plexus (fig. 296) ; (2) to the trachea ; (3) to the œsophagus. The terminal part of each nerve passes amongst branches of the inferior thyroid arteries on the laryngeal surface of the lateral lobes of the thyroid gland, and enters the larynx behind the inferior horn of the thyroid, lying on the cricoid cartilage. The termination in the muscles of the larynx will be seen later.

Ganglia of the Cervical Sympathetic.—In the dissection of the dorsal and lumbar regions, the ganglia were seen to correspond in number with the spinal nerves, each nerve having its vertebral ganglion in the sympathetic cord. As there are eight spinal nerves in the cervical region, eight cervical ganglia might be expected, but there are only three, the inferior,

FIG. 296.—DIAGRAM OF THE NERVES ENTERING INTO THE FORMATION OF THE CARDIAC PLEXUSES. (*Clark.*)



1. Superior cervical ganglion of the sympathetic. 2. Middle ganglion. 3. Inferior ganglion. 4. Superior cervical sympathetic cardiac branch. 5. Middle cardiac. 6. Inferior cardiac. 7. First dorsal sympathetic ganglion. 8. Second dorsal ganglion. 9. Vagus. 10. Recurrent laryngeal. 11. Superior cervical cardiac branch of vagus. 12. Middle cardiac branch of vagus. 13. Inferior cardiac branches of vagus. 14. Cardiac branches of left recurrent nerve. 15. Superficial cardiac plexus and ganglion. 16. Communicating branches between deep and superficial plexus. 17. Deep cardiac plexus. 18. Right and, 19. Left coronary plexuses.

middle, and superior. The upper probably represents four ganglia, as it is connected by grey rami communicantes with the upper four cervical nerves; the middle and inferior, two each; the middle is connected with the fifth and sixth, the inferior ganglion, with the seventh and eighth cervical nerves.

The INFERIOR CERVICAL GANGLION (see figs. 293, 30, 297) is situated above the neck of the first rib and will be seen by displacing the termination of the jugular vein and first stage of the subclavian artery, behind which it lies. The vertebral artery, a branch of the subclavian, ascends on its outer side (fig. 301, p. 89). Efferent fibres, which reach the upper dorsal vertebral ganglia from the four upper dorsal nerves, by the white rami communicantes, stream upwards both in front of and behind the subclavian artery, and unite the first dorsal ganglion with the inferior cervical. The fibres of the sympathetic cord, which thus unite the upper dorsal and inferior cervical ganglia, form the *annulus of Vieussens.* Not uncommonly these two ganglia are partially fused behind the subclavian artery. The ganglion sends outwards grey communicating rami to the seventh and eight cervical nerves; a white ramus may join it from the eighth nerve; it sends inwards a branch (splanchnic or cardiac) to join in the deep cardiac plexus (figs. 293, 294). It is connected with the middle cervical ganglion by the cervical sympathetic cord. Vaso-motor fibres pass from it to be distributed to the upper extremity and parts of the head and neck on the subclavian artery and its ramifications. A large plexus passes on the vertebral artery.

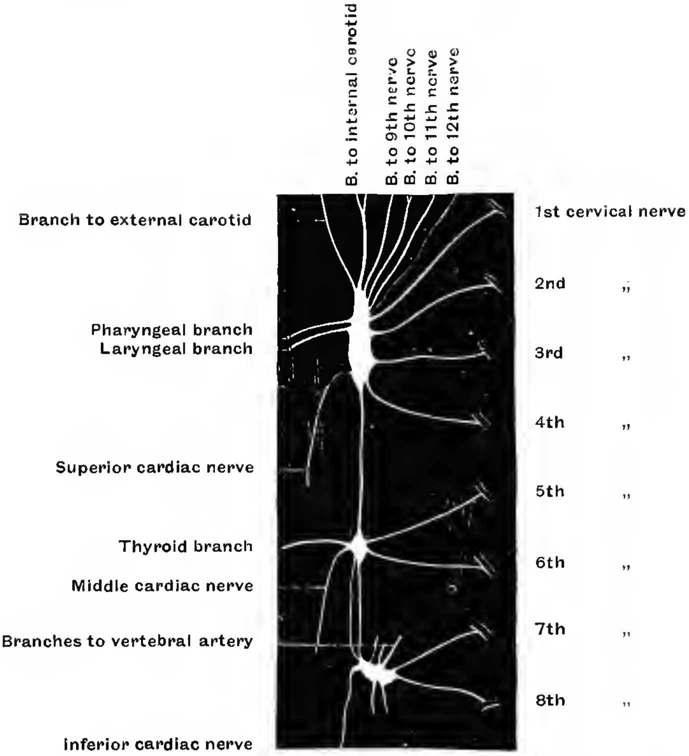
The MIDDLE CERVICAL GANGLION (see figs. 293, 24, and 294, 23) is small and may be absent. It is situated on or behind the inferior thyroid artery. Two grey communicating rami leave it for the fifth and sixth cervical nerves; the middle cardiac branch passes downwards to the deep cardiac plexus. The sympathetic cord between the inferior, middle, and superior ganglia is composed mostly of fibres streaming from the upper dorsal segments of the spinal cord to the head and neck. They are the vaso-motor and secretory nerves for the head, and the motor nerves for the non-striated muscles of the eye and orbit. Nerves for the thyroid body leave the middle ganglion on the inferior thyroid arteries.

The SUPERIOR CERVICAL GANGLION is by far the largest of the three, but only the lower end of it can be seen at present.

Four grey communicating rami pass from it to the upper four cervical nerves. The superior cardiac branch passes from the ganglion and unites with cardiac branches of the vagus, which arise, in part at least, from the superior and external laryngeal branches (fig. 292).

A plexus has been already traced from the superior ganglion to the external carotid artery and all its branches and to the inter-carotid body. Fibres pass to the thyroid body on the superior thyroid artery.

Fig. 297.—Diagram of the cervical sympathetic cord and ganglia. (*Heath.*)

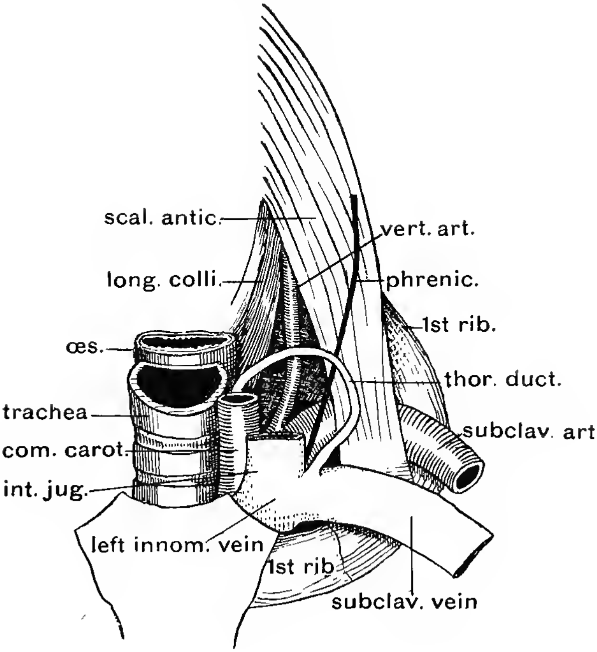


Nerves for the Heart (figs. 296, 297).—It will be thus seen that six cardiac nerves arise on each side of the neck, three from the vagus and three from the sympathetic ganglia. The superior sympathetic and inferior vagal branches of the left side pass in front of the arch of the aorta and end in the superficial cardiac plexus (fig. 296); all the others pass behind the arch by the side of the trachea and end in the deep cardiac plexus. The arrangement of these nerves in the neck is plexiform; they communicate freely, and their points of origin are irregular.

Lymphatic Structures beneath the Sterno-Mastoid.

(1) Cervical Stage of the Thoracic Duct.—After commencing in the abdomen, where it receives the chyle and lymph of the abdomen and lower extremities, the thoracic duct passes through the posterior and superior mediastinal spaces and reaches its terminal stage on the left side of the neck, beneath the sterno-mastoid (fig. 298).

Fig. 298.—The cervical stage of the thoracic duct. The clavicle, sterno-mastoid, and internal jugular vein have been removed to expose it. (*F. W. Jones.*)



It should be looked for and found as it enters the left innominate vein in the angle between the jugular and subclavian veins. Here it lies on the scalenus anticus and phrenic nerve (fig. 298). It may contain some blood and be mistaken for a vein. As it is followed inwards, it passes behind the jugular vein and left common carotid artery and in front of the vertebral artery and vein. It reaches the left side of the œsophagus and longus colli muscle, and passes into the superior mediastinum behind and to the inner side of the left subclavian artery. In the neck the duct makes a hook-like bend behind the left common carotid artery and jugular vein to reach its termination where it is joined by the efferent vessels of the deep cervical glands.

(2) Right Lymphatic Duct.—The right lymphatic duct receives the lymph of the right side of the head and neck, the right arm and right side of the thorax. It enters the outer end of the right innominate vein in the angle between the jugular and subclavian veins, but it is closely surrounded by connective and glandular tissue, and is difficult to display satisfactorily.

(3) Cervical Lymphatic Glands (fig. 284, p. 45).—The majority of the deep cervical glands lie beneath the sterno-mastoid. Some were seen in the superior carotid, subclavian, and occipital triangles. One which receives the lymph of the larynx will be found on the posterior part of the thyro-hyoid membrane. Others will be found by the side of the œsophagus and trachea (para-tracheal) continuous with the bronchial group of glands and those of the superior mediastinum. The para-tracheal glands receive efferent vessels from the thorax, trachea, œsophagus, larynx, and thyroid gland.

Internal Jugular Vein. Course.—The internal jugular vein commences in the jugular foramen where it receives the intra-cranial blood. The first stage lies in the sub-parotid space (p. 195, fig. 369).

It then enters the superior carotid triangle (fig. 291, p. 61) and gradually passes beneath the sterno-mastoid; it lies beneath the lower two-thirds of that muscle in the natural position of the parts; it joins with the subclavian vein to form the innominate behind the inner end of the clavicle.

Relations.—It is contained in the outer compartment of the carotid sheath, the carotid artery lying at its inner side, the vagus nerve behind and to its inner side. The spinal accessory crosses its commencement (fig. 291, p. 61). Behind it lie the anterior tubercles of the transverse processes and the muscles attached to them (see p. 73). Below, it lies in front of the first stage of the subclavian artery, and the branches which arise from that stage (Plate XLVI, p. 70), the inner part of the scalenus anticus and phrenic nerve. On the left side the thoracic duct passes behind it. The deep cervical glands are clustered over it, and, when diseased, become adherent to it.

TRIBUTARIES.—The temporo-facial, pharyngeal, lingual, superior and middle thyroid veins, which have already been examined (p. 63).

Subclavian Vein. COURSE.—The subclavian vein is much shorter than the artery, being little more than an inch in length. It is the inward continuation of the axillary vein, commencing behind and below the clavicle at the outer border of the first rib. It ends behind the inner end of the clavicle by joining the internal jugular to form the innominate vein (fig. 285, p. 47).

RELATIONS.—The subclavian vein lies in a groove on the upper surface of the first rib and in front of the insertion of the scalenus anticus (Plate XLVI, p. 70). The phrenic nerve passes behind its junction with the jugular vein. The second and third stages of the subclavian artery lie behind it and at rather a higher level. It lies almost completely behind the clavicle and subclavius muscle.

TRIBUTARIES.—The external jugular vein joins it usually at the posterior border of the sterno-mastoid. Through this tributary it receives the blood of the anterior jugular, transverse cervical, and supra-scapular veins.

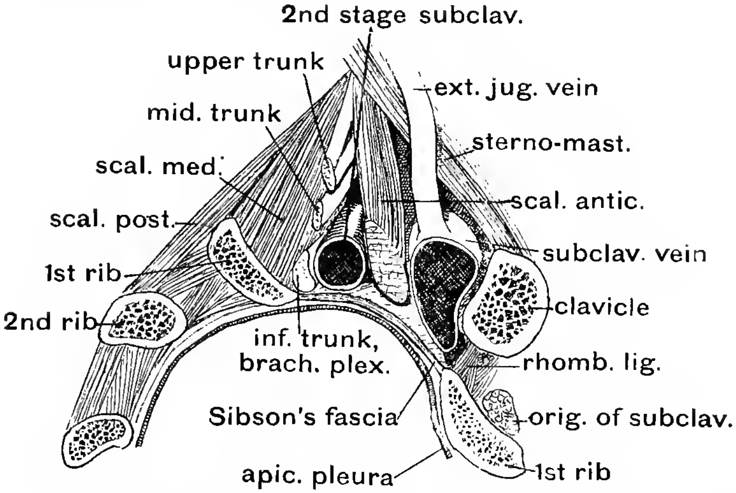
Innominate Veins.—The two innominate veins lie in the superior mediastinum; they commence, however, in the neck, behind the inner extremities of the clavicles. They unite to form the superior vena cava. Each receives two tributaries from the neck, the vertebral and inferior thyroid veins.

All the veins of the neck are now to be cleared away.

Scalenus Anticus. RELATIONSHIPS.—The scalenus anticus (figs. 298, 299, 301), which has a great number of important relationships, lies beneath the sterno-mastoid. At its insertion to the first rib it passes in front of the subclavian artery, dividing that vessel into three stages (fig. 300, p. 88). The second stage of the artery lies behind the muscle, the terminal part of the subclavian vein lies in front of it. The phrenic nerve descends on its anterior surface, the thoracic duct bends outwards on the left muscle (fig. 298). The internal jugular vein descends along its origin and on its inner border (Plate XLVI, p. 70).

When a finger is passed downwards along its *outer* border the scalene tubercle of the first rib is recognised. This is a valuable guide to the surgeon when operating; from it he can determine the position and nature of the surrounding vessels. At the lower part of the origin of the muscle the anterior tubercle of the transverse process of the sixth cervical vertebra is greatly enlarged. It lies behind the carotid artery, which may be compressed against it, and hence is known as the *carotid tubercle*.

FIG. 299.—VERTICAL SECTION AT THE JUNCTION OF NECK AND THORAX TO SHOW THE RELATIONSHIP OF SIBSON'S FASCIA (APICAL FIBROUS DOME) TO THE SUBCLAVIAN VESSELS AND INFERIOR TRUNK OF THE BRACHIAL PLEXUS.



Between the inner border of the scalenus anticus and the outer border of the longus colli muscle, there is a triangular interval containing the first stage of the vertebral artery. The first stage of the subclavian artery forms a base for this, the *vertebral triangle* (fig. 301).

At its insertion, the deep surface of the scalenus anticus is in contact with the *apical fibrous dome* (Sibson's fascia) of the thorax and apical pleura (fig. 299). Fibres of the muscle frequently end in the fibrous tissue over the apical part of the pleura. Behind the scalenus anticus the nerves of the brachial plexus emerge (Plate XLVI, p. 70).

Origin.—From the anterior tubercles of the transverse processes of the cervical vertebræ from the 3rd to the 6th (fig. 301).

Insertion.—By tendinous fibres to the scalene tubercle and upper surface of the first rib, between the grooves for the subclavian vessels.

Nerve Supply.—From the 4th and 5th cervical nerves (fig. 295, p. 74).

Action.—It belongs to the intercostal series of muscles, both morphologically and physiologically. If the neck is fixed it elevates the first rib; but, as is commonly the case, it acts from the first rib, flexing the neck laterally and balancing the head.

Scalenus Medius (fig. 383, p. 222). Origin.—From the *posterior tubercles* of the transverse processes of all the cervical vertebræ except the first.

Insertion.—To the rough upper surface and ridge of the first rib between the groove for the subclavian artery in front and the tuberosity behind (fig. 299).

Nerve Supply.—From the 3rd and 4th cervical nerves.

Action.—The action is similar to that of the scalenus anticus.

The nerves to the rhomboids and serratus magnus perforate the muscle; the nerves of the brachial plexus appear in front of it (Plate XLVI, p. 70). Its origin lies beneath the sterno-mastoid; its insertion beneath the trapezius; its middle part helps to form the floor of the posterior triangle.

Scalenus Posticus.—This is really that part of the scalenus medius which is inserted to the second rib (fig. 299). It rises with the scalenus medius from the lower two or three transverse processes, and is inserted to the second rib near its angle.

Origin of the Arteries of the Head and Neck.—The innominate artery is the first great trunk of the arch of the aorta. It ascends obliquely in the superior mediastinum on the right side of the trachea and, at a point which is marked on the surface by the sterno-clavicular joint, divides into right common carotid and right subclavian arteries. Its point of origin is in front of the trachea; at its point of bifurcation it lies on the right side of the trachea.

The left common carotid is the second arterial trunk of the aortic arch. It also ascends in the superior mediastinum, passing from the anterior aspect to the left side of the trachea. Its point of entrance into the neck is marked on the surface of the body by the left sterno-clavicular joint.

The LEFT SUBCLAVIAN ARTERY is the last of the three great branches of the aortic arch. It rises in the superior mediastinum; it passes upwards and enters the neck behind the left common carotid artery.

From their points of entrance in the neck the courses of the arteries of the left and right side correspond.

Common Carotid Artery. COURSE.—The course of the common carotid artery, which supplies the main parts of the head, neck and brain with blood, is indicated on the neck by a line drawn from the sterno-clavicular joint to a point midway between the ascending ramus of the jaw and mastoid process. The point of bifurcation into internal and external carotid arteries lies at the level of the thyro-hyoid membrane. The artery is placed (1) beneath the anterior border of the sterno-mastoid, gradually emerging to lie (2) in the superior carotid triangle (fig. 292, p. 64). The common carotid artery commences in front of the subclavian. It gives off no branches except its terminal divisions.

RELATIONSHIPS.—The artery occupies the inner compartment of the carotid sheath, the jugular vein being to its outer side, and the vagus nerve behind and to its outer side. It occupies a triangular interval between the trachea, lateral lobe of the thyroid and pharynx internally and the cervical transverse processes behind (figs. 282 and 290).

The artery (fig. 282, p. 42) lies in front of the anterior tubercles of the transverse processes of the neck and the muscles attached to those processes (rectus capitis anticus major and longus colli). The anterior tubercle of the 6th vertebra forms the *carotid* tubercle; against it the artery may be compressed beneath the sterno-mastoid. The cervical part of the sympathetic cord descends behind the carotid sheath; the inferior thyroid artery ascends behind it; the recurrent laryngeal nerve lies at its inner side below (fig. 289, p. 58). The anterior belly of the omo-hyoid crosses it at the level of the cricoid cartilage.

Subclavian Artery (fig. 300).—The subclavian arteries are the arterial trunks for the upper extremities, but as they cross the neck on the apex of the lung (fig. 299) they also give off a number of important branches for the thorax, thyroid gland, shoulders, lower parts of the neck, and brain.

ORIGIN.—The right artery arises as one of the terminal branches of the innominate artery, its commencement being covered by the right common carotid. The left arises in the superior mediastinum from the arch of the aorta.

COURSE (fig. 300).—Its position on each side of the neck is indicated on the surface by a curved line drawn from the inner end to the middle point of the clavicle; the curve rises half an inch above the level of the clavicle, behind the clavicular head of the sterno-mastoid. Its relationship to the clavicle depends on the position of the shoulder. If the arm is raised, the clavicle rises above the level of the artery. The artery becomes the axillary at the outer border of the first rib; here it passes into the apex of the axilla behind the clavicle.

STAGES.—The scalenus anticus divides it into three stages: the first lies internal to the muscle, the second behind it, the third external to it (fig. 300).

RELATIONSHIPS. (1) *To Muscles.*—The first and second stages lie behind the sterno-mastoid; the second is also behind the scalenus anticus. The third stage lies beyond the sterno-mastoid and has been examined in the subclavian triangle. The longus colli is placed behind the commencement of the first stage; the scalenus medius behind the third.

(2) *To Veins.*—The internal jugular descends in front of the first stage and there unites with the subclavian to form the innominate vein (Plate XLVI, p. 70). The subclavian vein lies in front of and below the third stage of the artery; it is separated from the second stage by the scalenus anticus. The external jugular vein, with its tributaries from the posterior and anterior triangles of the neck, crosses the third stage of the artery. The vertebral vein passes downwards in front of the first stage.

(3) *To Nerves.*—The first stage is crossed by the phrenic; on the right side the vagus crosses it; on the left the nerve descends between the left common carotid and first stage of the artery. The annulus of Vieussens surrounds the first stage; the inferior cervical and first dorsal ganglia lying behind it. The nerve to the subclavius crosses the third stage; the inferior trunk of the brachial plexus lies behind it; the middle trunk is situated above it.

(4) *To Lung, Pleura, and Apical Fibrous Dome.*—The sub-

clavian artery in its first and second stages grooves the inner and anterior surface of the apex of the lung (fig. 299, p. 83). It is separated from the lung by the apical pleura and the fibrous dome of tissue which covers it. The third stage of the artery is separated from the pleura by the first rib.

(5) *To Lymphatic Structures.*—The thoracic duct ascends behind the intra-thoracic stage of the left subclavian; in the neck, the duct arches outwards above the artery. The inferior group of deep cervical glands lies above and in front of it.

Branches of the Subclavian Artery.

(1) Inferior Thyroid.	Thyroid Axis.	First Stage.
(2) Transverse Cervical.		
(3) Suprascapular.		
(4) Internal Mammary.		
(5) Vertebral.		
(6) Superior Intercostal.	Costo-cervical Trunk.	Second Stage.
(7) Deep Cervical.		
(8) Posterior Scapular.	(Occasionally.)	Third Stage.

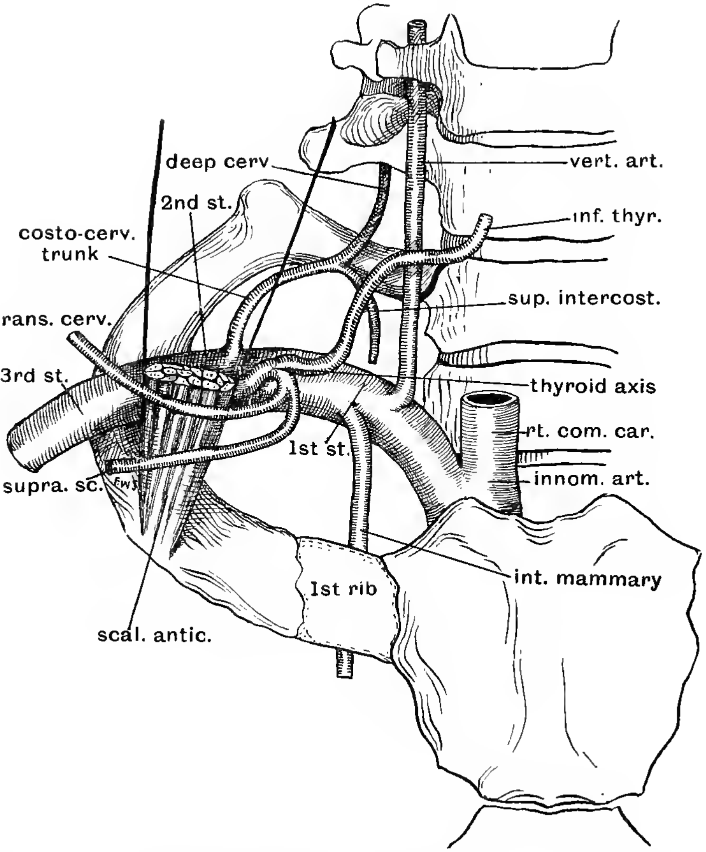
Thyroid Axis (fig. 300).—This short trunk arises from the first stage behind the commencement of the innominate vein, and divides into the following three arteries: the inferior thyroid, the suprascapular and transverse cervical. One or other of these arteries may spring directly from the main trunk.

Inferior Thyroid Artery.—The inferior thyroid artery ascends behind the carotid sheath and loops inwards and downwards to reach the side of the trachea. There it supplies (*a*) œsophageal branches, (*b*) tracheal branches, (*c*) laryngeal branches, (*d*) terminal branches to the lower and posterior aspects of the thyroid gland. Its terminal branches surround the inferior laryngeal nerves, the laryngeal branches accompanying the nerve to the larynx. The artery is looped to allow for the movements of the larynx and trachea.

Ascending Cervical Artery.—Besides these smaller branches, the inferior thyroid, as it passes behind the carotid sheath, gives off the ascending cervical artery (Plate XLVI, p. 70). This ascends between the attachments of the muscles to the anterior tubercles of the cervical transverse processes. Its terminal twigs anastomose with the branches of the occipital and deep cervical arteries. The deep cervical artery passes up on the dorsal aspect of the vertebræ (fig. 384, p. 225). Both give off spinal branches which anastomose with the vertebral and end in the spinal canal and cord.

Suprascapular Artery (fig. 271, page 13).—The suprascapular arises from the thyroid axis and passes outwards under the sterno-mastoid and behind the clavicle. It crosses the subclavian triangle to reach the scapula (Plate XLVI, p. 70).

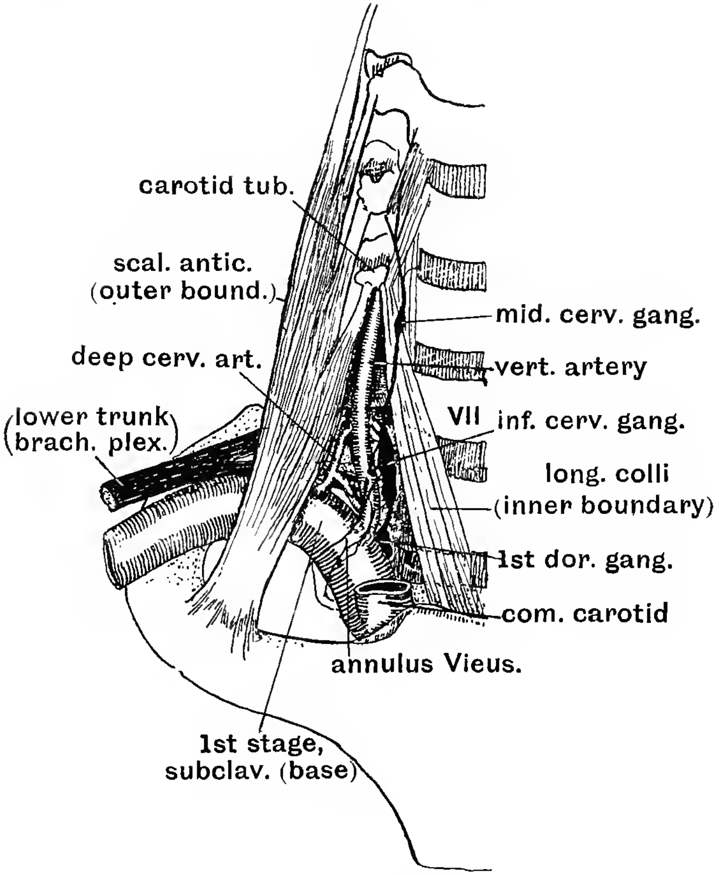
Fig. 300.—Diagram of the stages and branches of the right subclavian artery. (*F. W. Jones.*)



Transverse Cervical Artery.—This trunk has been already examined (fig. 271, p. 13). It arises from the thyroid axis, and crosses in front of the scalenus anticus and phrenic nerve to the posterior triangle of the neck. It ends at the anterior border of the levator anguli scapulæ by dividing into *posterior* *scapular* and *superficial cervical* (see pages 12, 13, 14). The posterior scapular may arise separately from the third stage of the artery.

Internal Mammary Artery.—This artery has a very short cervical stage (fig. 300). It passes downwards between the innominate vein and sternal end of the first rib in front and the pleura behind. It is distributed to the walls of the thorax and abdomen.

Fig. 301.—The boundaries of the vertebral triangle and its contents.



Vertebral Artery.—This artery passes through a tortuous course to reach the brain. It will be examined more minutely at a later stage of the dissection (fig. 384, p. 225). Its *first* *stage* (fig. 301) lies in a triangle bounded externally by the scalenus anticus and internally by the longus colli; the first stage of the subclavian artery forms the base of the triangle. The artery enters the vertebral canal (its *second stage*) below the carotid tubercle on the sixth transverse process. The terminal part of the jugular vein lies in front of the vertebral.

Costo-cervical Trunk.—This artery arises from the subclavian behind the scalenus anticus. It passes backwards against the neck of the first rib and divides into the *superior intercostal*, which descends in front of the neck of the rib, and the *deep cervical*, which passes backwards between the neck of the first rib and the transverse process of the last cervical vertebra (figs. 300, 301).

The SUPERIOR INTERCOSTAL ARTERY ends in the first two intercostal spaces.

The DEEP CERVICAL ARTERY ascends beneath the complexus and anastomoses with the occipital and vertebral arteries in the sub-occipital triangle (fig. 273, p. 20).

Deep Stage of the Occipital Artery.—The distribution of the occipital artery on the scalp has been already examined (fig. 273, p. 20). It arises from the external carotid beneath the posterior belly of the digastric and at first lies in the superior carotid triangle. Passing backwards under cover of that muscle, it enters its *deep stage* and grooves the occipital bone internal to the digastric fossa. It proceeds upwards and backwards on the insertion of the superior oblique and complexus muscles. The mastoid process and the three muscles which end on it—the sterno-mastoid, splenius capitis, and trachelo-mastoid—lie superficial to the artery (fig. 305, p. 100). It supplies branches to the sterno-mastoid and muscles inserted to the mastoid process.

MASTOID ARTERY.—The small mastoid artery, which enters by the mastoid foramen to supply the meninges, is a branch of the deep stage.

PRINCEPS CERVICIS (fig. 273, p. 20).—This is an artery of considerable size which arises from the deep stage as the occipital artery passes along the superior oblique muscle. It supplies the muscles covering the sub-occipital triangle, and ends in the triangle by anastomosing with the vertebral and deep cervical arteries.

DISSECTION VII

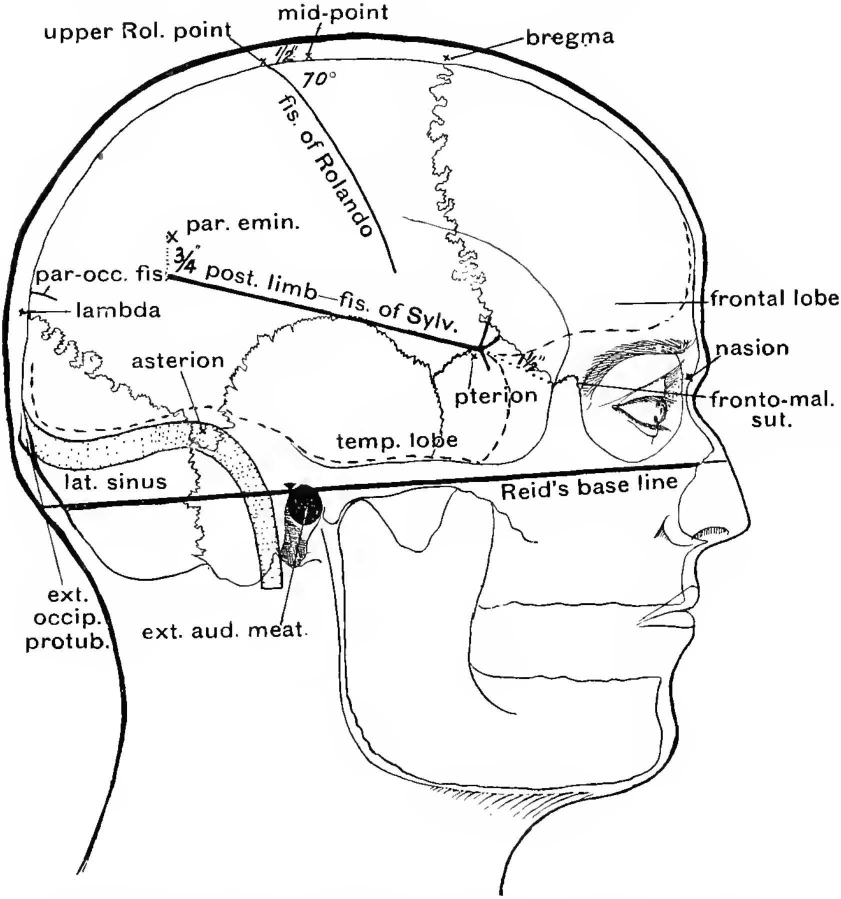
DISSECTION OF THE SCALP, EXPOSURE AND REMOVAL OF THE BRAIN

Surface Markings of the Head.—Before ever putting a knife to this part the student must sit down and, with a skull beside him, make out on the head the various points which guide a surgeon to the important structures which lie deep in the head. None are more important than the four corners of the parietal bone (fig. 302). The anterior inferior angle (the *pterion*) lies 1½ inches behind and ¼ inch above the level of the fronto-malar suture; at this point the anterior division of the middle meningeal artery passes upwards, grooving the inner surface of the parietal, and is liable to be torn in fractures of the temporal region of the skull. Beneath the pterion, at the *Sylvian point*, the three limbs of the fissure of Sylvius meet (fig. 302). Under the posterior inferior angle of the parietal (the *asterion*), a point often required for operation, lies the convexity of the lateral sinus. The asterion may be indicated thus: draw a line from the *lambda*, the posterior superior angle of the parietal, to the lower border of the auditory meatus; the junction of the lower and middle thirds of this line lies over the asterion. The *lambda* can, as a rule, be distinctly felt through the scalp; it lies between 2½ and 3 inches above the external occipital protuberance. Half an inch in front of the lambda is the parieto-occipital fissure, the meeting-point between the occipital and parietal lobes of the brain (fig. 302). The anterior superior angle, the *bregma*, if it cannot be felt, may be indicated by drawing a line across the crown from the front of one meatus to the front of the other; such a line crosses the anterior end of the sagittal suture at the bregma. The bregma marks a point over the frontal lobe of the brain 2 inches in front of the upper end of the fissure of Rolando, which separates the frontal from the parietal lobe.

The PARIETAL EMINENCE can be distinctly felt; the Sylvian fissure terminates about ¾ in. below it. Behind and below the eminence is situated the angular gyrus of the parietal lobe, in which the 'word-seeing' centre is situated.

Position of the Venous Sinuses.—The position of the great venous channels within the skull may be easily remembered. The *superior longitudinal sinus* commences in the middle line of the forehead above the root of the nose and runs backwards in the middle line under the frontal, parietal, and occipital bones to terminate beneath, or slightly above, the *external occipital protuberance* (inion) by joining either the right or left lateral sinus. The *lateral sinus*, starting from the inion, runs transversely outwards to the asterion, where it turns downwards beneath the mastoid, about ¾ inch behind the meatus (fig. 302).

Fig. 302.—The chief surface markings of the head. (*F. W.*



The Lower Limits of the Brain.—Since the lateral sinus projects inwards between the cerebrum above and cerebellum below, any opening made above that sinus, the superficial markings of which have just been given, will expose the posterior part of the cerebrum, while below that line, covered by the insertions of the neck muscles, will be found the cerebellum. Between the ear and the eye, the lower limit of the cerebrum—at this part, the temporal lobe—is marked by the upper border of the posterior two thirds of the zygoma ; below that line lies the zygomatic fossa (fig. 302). On the forehead the lower limit of the brain cannot be easily indicated. The frontal lobes rest on the thin roofs of the orbits, but the development of the frontal sinuses and the supra-orbital ridges over the anterior parts of the orbital roofs prevent the lower border of the frontal lobes from coming to the surface (Plate XLVII, p. 98). A line drawn from the pterion of one side to the pterion of the opposite side, above the eyebrows, will sufficiently indicate the lower limit of the brain on the forehead and temples.

How to Expose the Fissure of Rolando.—Before proceeding to the regular dissection of the scalp, the student may obtain a clearer idea of the various structures which cover and protect the brain by exposing, as the surgeon has frequently to do, a part of the fissure of Rolando. This fissure descends on the surface of the brain near the hinder limit of the cortex in which the motor areas are situated. The position of the fissure is indicated thus (fig. 302) : its upper end (*upper Rolandic point*) is found on the sagittal suture by measuring the distance along the crown of the head from the *nasion* (fronto-nasal suture) to the *inion* (external occipital protuberance) ; half an inch behind the mid-point of this line (about 2 inches behind the bregma) lies the upper end of the fissure. Below, the fissure ends near the lower border of the parietal bone and 1½ inches behind the pterion.

Mark out this line on the side of the head ; it should run downwards and forwards at an angle of about 70° with the sagittal suture (fig. 302). Beneath the middle third of this line, in front of it and to a small extent behind it, lie the centres for movements of the arm, hand and fingers. It is this area of cortex which should now be exposed.

Make a horse-shoe incision, two inches wide from heel to heel, right down to the bone over the middle third of the Rolandic line, with the heel parts of the incision below and its convexity above.

The Layers of the Scalp (fig. 303).—As the flap is raised, a thin membranous layer will be observed to adhere closely to the bone, from which it has to be peeled off. It is really the periosteum of the bone (fig. 303), but on the cranial vault the periosteum receives the name of *pericranium*. The pericranium contains the nutrient vessels for the superficial lamellæ of the skull; hence, if the membrane is scraped away during life, the outer lamellæ die.

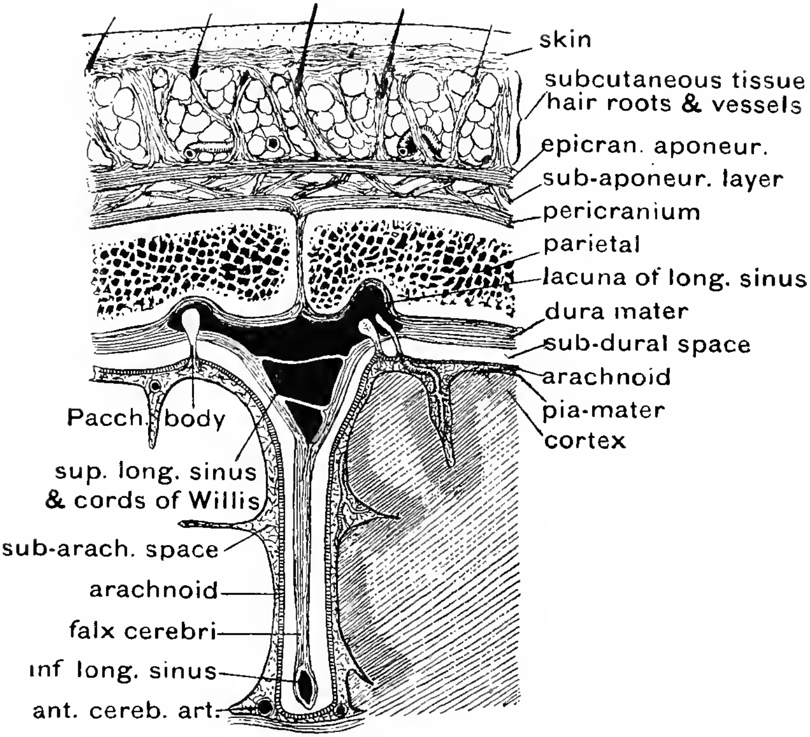
The scalp is composed mainly of three layers closely united together (fig. 303): the *first* is the skin proper, the *second* represents the subcutaneous tissue, here composed of pellicles of fatty tissue matted together by fibrous bands; it can be seen to contain the hair-roots, sebaceous glands (which may become closed and dilated into large cysts) and the vessels and nerves which supply the scalp; the *third* layer is the epicranial aponeurosis, representing the platysma layer of muscle of the face and neck. These three layers, which are firmly bound together, are attached to the pericranium by a *fourth* layer (sub-aponeurotic) of extremely lax connective tissue which permits free movement of the scalp, and offers free scope for the spread of pus or blood.

Thus the flap, which has been raised to expose the bone, contains the following five layers:

(1) Skin.
(2) Sub-cutaneous tissue. } Compose the movable scalp.
(3) Epicranial aponeurosis.
(4) Sub-aponeurotic layer.
(5) Pericranium.

With a trephine, or better still with a chisel and mallet, remove the piece of parietal bone beneath the flap. Notice its outer and inner tables, with the cancellous tissue (diploë) between, containing the diploic veins (fig. 303). The rough outer surface of the *dura mater* is exposed when the bone is removed (fig. 303). It is rough because its outer layer sends fibres and vascular twigs into the bone, and serves as a periosteum. When a window is made in the dura mater, the cortex of the brain, covered by the *arachnoid membrane*, is exposed (fig. 303). The inner surface of the dura mater is perfectly smooth, so is the outer surface of the arachnoid, for each is covered by tesselated endothelium; the space between the two membranes is the *subdural.* In life there is no actual space; the membranes are in contact, just as are the parietal and visceral layers of the pleura, to which the inner layer of the dura mater and outer of the arachnoid correspond.

FIG. 303.—A SECTION OF THE SCALP, SAGITTAL SUTURE, LONGITUDINAL SINUS, FALX CEREBRI, AND MENINGES. (*Diagrammatic.*)



The arachnoid will be seen to be bound to the cortex by lax, fine connective tissue. This tissue makes up the third and deepest of the cerebral meninges or coverings—the *pia mater.* The spaces beneath the arachnoid (sub-arachnoid), amidst the fibres of the pia mater, contain cerebro-spinal fluid. In the pia mater ramify also the vessels which nourish the cortex; hence, if it be stripped off, the cortex beneath dies.

Through the opening thus made in the membranes, running from above downwards, should be seen the fissure of Rolando, with the ascending frontal convolution in front of it, and the ascending parietal behind it (see fig. 440, p. 319). An incision will show that the grey cortex is only about an eighth of an inch deep. If it be suitably stimulated in life, definite movements are obtained in the arm, according to the part excited.

Having thus gained a knowledge of the main structures covering the brain, the student should now dissect each of them in detail.

Dissection of the Scalp. INCISIONS.—An incision has already been made across the crown from ear to ear. Another is made from the root of the nose to the external occipital protuberance. The scalp is thus divided into four segments, two frontal and two occipital, or, more correctly, parieto-occipital. The frontal segments are to be dissected first.

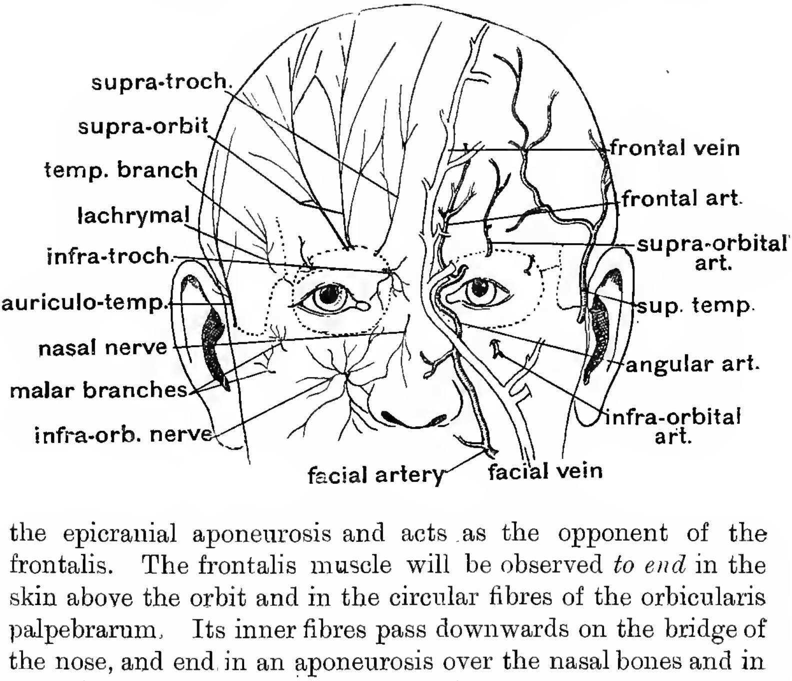
The Frontal Segments of the Scalp.—Dissection is commenced at the upper angle of the frontal flap. The angle should be dissected up, right down to the bone, and the five strata of the scalp, enumerated above, recognised. Each layer should then be dissected off, down to the base of the flap, which is situated above the orbit and zygoma.

As the student throws the skin off the forehead, he should remember that the surgeon has occasionly to raise from it flaps which are turned down to supply deficiencies on the nose or face. Such a flap may be raised from the forehead, with its base above the inner angle of the orbit, so as to contain the *frontal artery*, a branch of the ophthalmic, which emerges from the orbit near its inner angle (fig. 304). The artery assists in supplying the frontal segment of the scalp. The *frontal vein* is commonly larger than the artery, and although it sends communicating branches to the upper ophthalmic vein within the orbit, its main part passes down between the eye and nose, and forms the commencement of the facial vein. During hard work this vein becomes prominent in the forehead. The *supra-trochlear nerve*, which accompanies the frontal artery, is commonly of small size and not easily found. It must be looked for beneath the frontalis muscle as it emerges from the orbit, but as it is followed upwards it is seen to gradually perforate the muscle, and lie in the sub-cutaneous tissue of the scalp.

The *sub-cutaneous tissue* of the forehead carries no fat, but above the forehead, where it contains the hair-roots, it becomes dense and firmly adherent to the skin and the epicranial aponeurosis, which is deep to it.

Frontalis Muscle (fig. 321, p. 128).—The student will find the cause of the lines and wrinkles of the forehead in the underlying frontalis muscle—one of the muscles of expression. After the muscular layer passes under the hair, it becomes transformed to a fibrous sheet—the *epicranial aponeurosis*. By acting on the aponeurosis it may pull the scalp forwards, but more commonly it uses the aponeurosis as a fixed basis, and pulls the eyebrows upwards, wrinkling the skin of the forehead. The *occipitalis* is attached to the posterior end of the epicranial aponeurosis and acts as the opponent of the frontalis. The frontalis muscle will be observed *to end* in the skin above the orbit and in the circular fibres of the orbicularis palpebrarum. Its inner fibres pass downwards on the bridge of the nose, and end in an aponeurosis over the nasal bones and in the skin. These fibres are distinguished as the *pyramidalis nasi*.

FIG. 304.—THE VESSELS AND NERVES OF THE FRONTAL SEGMENTS OF THE SCALP.



Corrugator Supercilii (fig. 322, p. 130).—The vertical lines or folds between the eyebrows are caused by the corrugator supercilii, a slip of muscle which lies beneath the frontalis and orbicularis. It takes its origin from the frontal bone, at the inner end of the superciliary ridge (Plate XLVII, p. 98), and passes upwards and outwards to end in the skin and muscle beneath the eyebrow and over the superciliary ridge.

Temporal Branches of Facial Nerve (see fig. 326, p. 135).—The muscles of the forehead are supplied from the facial nerve by numerous temporal branches, which may now be found in the superficial tissue over the anterior half of the zygoma.

The Nerves of the Frontal Segments of the Scalp.—The incision which the student drew across the crown from ear to ear separates two nerve areas. The frontal segments of the scalp are supplied from the fifth pair of cranial nerves, the occipital segments from the second and also slightly from the third pair of spinal nerves. All three divisions of the fifth nerve take a part in supplying each frontal segment.

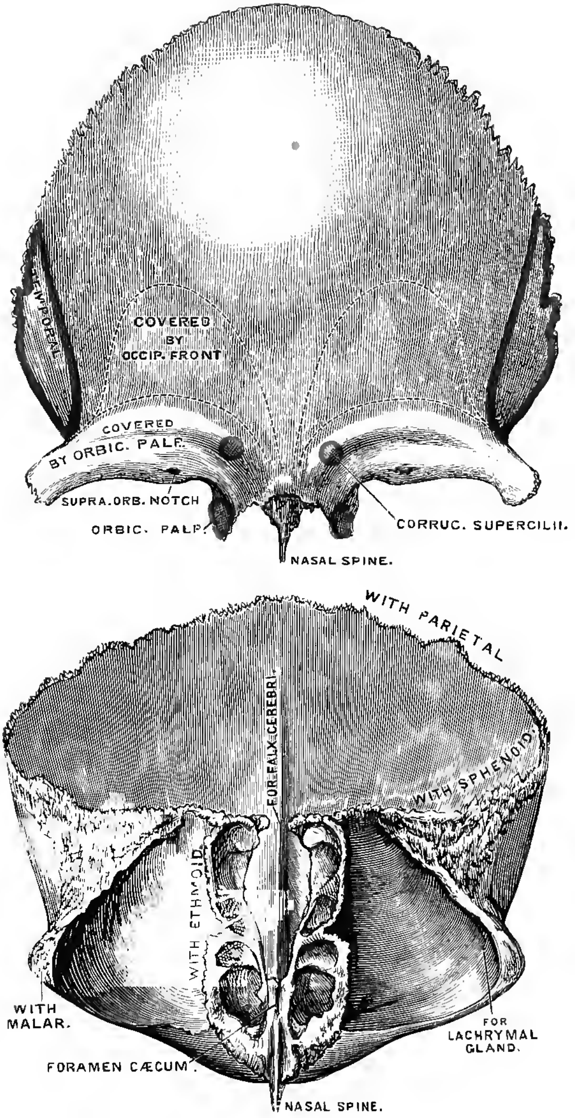
Branches from the First Division of the Fifth Nerve.—The first division contributes three branches, the *supra-trochlear*, the *supra-orbital*, and terminal twigs of the *lachrymal* (fig. 304). Of these the supra-orbital is by far the largest, and both it and the supra-trochlear may require division when they are the seats of intractable neuralgic pains. The supra-orbital nerve is found emerging from the roof of the orbit at the junction of the inner and middle thirds, the spot being, as a rule, easily recognised by the notch in which the nerve lies. To see it at the point of emergence, the orbicularis and frontalis muscles must be cut through. The nerve divides into a larger outer and a smaller inner branch, which perforate the frontalis muscle as they pass upwards to reach the upper limits of the frontal segments. The point at which the supra-trochlear nerve must be sought for has already been mentioned. Afterwards, when the roof of the orbit is removed, the supra-orbital and supra-trochlear nerves will be seen to be the terminal branches of the frontal nerve, a branch of the first division of the fifth (fig. 335, p. 150). The lachrymal nerve also will be found then, and its terminal twigs more easily traced into the skin at the upper and outer angle of the orbit than they can be at the present stage of dissection.

Branch from the Second Division of the Fifth (fig. 304).—The second division of the fifth only contributes a minute twig, the *temporal branch* of the temporo-malar, to the frontal segment of the scalp. If the subcutaneous tissue is raised from behind the external angular process by the handle of the scalpel, the temporal nerve will be found escaping through the

PLATE XLVII

THE OUTER AND INNER ASPECTS OF THE FRONTAL BONE.

(*H. E. Clark.*)



deep temporal fascia. The foramen by which it leaves the outer wall of the orbit and passes into the temporal fossa should be examined in the dried skull.

Branch from the Third Division.—The *auriculo-temporal* nerve (fig. 304) is the contribution from the third division of the fifth to the sensory supply of the frontal segment. The nerve will be found crossing the base of the zygoma in front of the ear, beneath and behind the superficial temporal vessels. It sends a branch to the helix and tragus of the ear and passes up on the temple to supply a narrow strip of skin above and in front of the ear.

Vessels of the Frontal Segment of the Scalp.—The blood supply of the frontal segment comes from two sources—the ophthalmic artery within the orbit (fig. 304), and the superficial temporal artery, a terminal branch of the external carotid (fig. 305). The ophthalmic artery gives off the following branches:

(*a*) The *frontal*, already mentioned.

(*b*) The *supra-orbital*, found with the corresponding nerve.

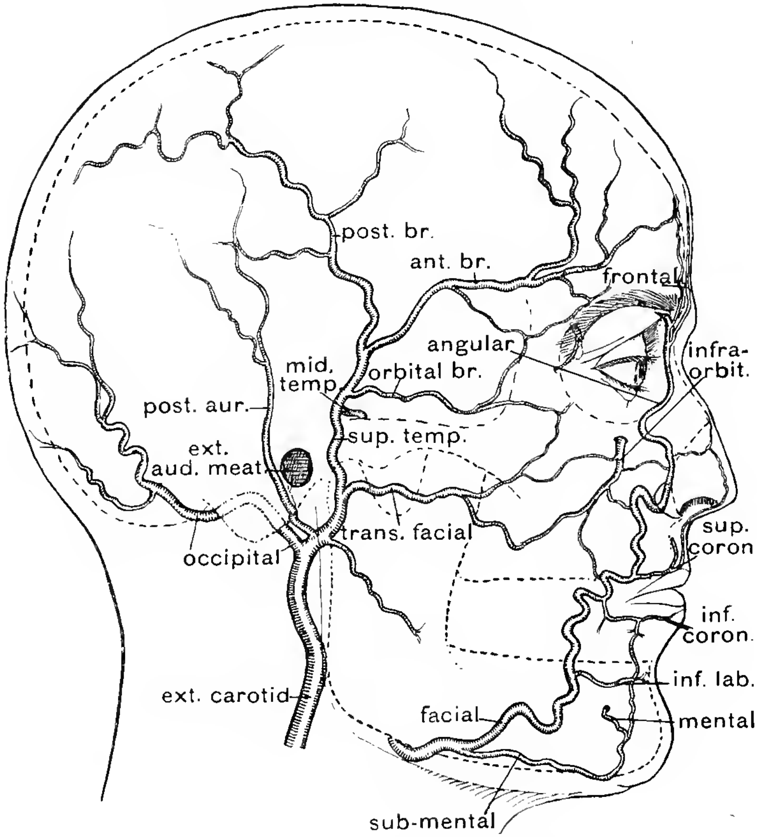
(*c*) Minute branches of the lachrymal to the skin over the upper and outer angle of the orbit.

The *superficial temporal*, from the external carotid, is found crossing the base of the zygoma in front of the ear, and after passing upwards for about an inch, it divides into a small posterior branch and a large anterior which, in old people and brain-workers, comes prominently into view as it winds forwards on the temple (fig. 305). It lies in the superficial fascia beneath the skin.

VEINS.—The blood of the forehead flows mostly into the *frontal vein* which conducts it to the facial (fig. 307). Near the supra-orbital notch the frontal diploic vein will be seen to emerge and join the supra-orbital vein. Through this tributary it receives blood from the frontal sinus, and when that sinus contains pus, the diploic vein may become a channel for the spread of infection through the frontal bone. The supra-orbital vein communicates with the ophthalmic and ends mostly in the frontal vein. The superficial temporal vein joins with the internal maxillary veins in the parotid gland to form the temporo-maxillary.

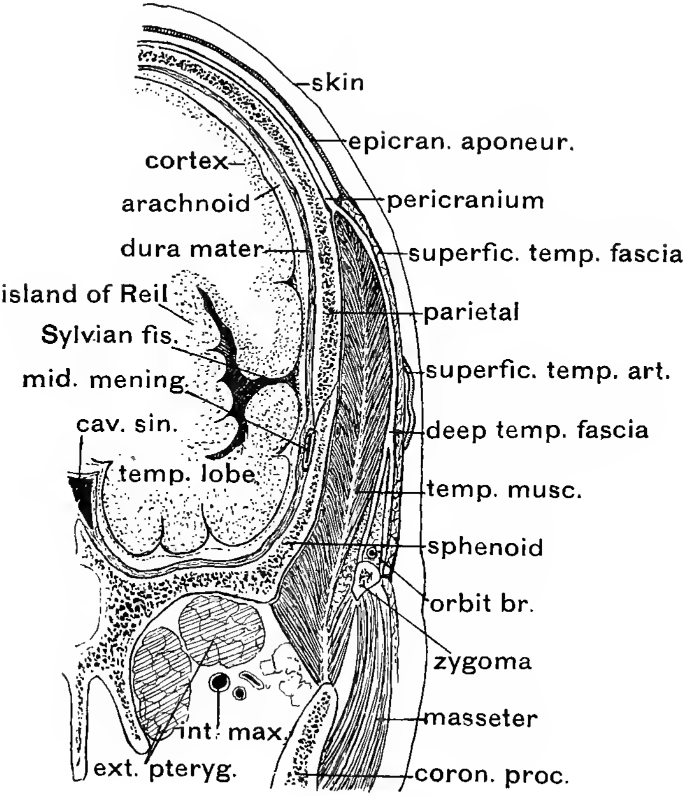
Superficial Coverings of the Temporal Region.—The temporal region becomes more and more frequently the site of operation, and hence it is important that the student should make himself familiar with the coverings of this region and their correspondence with the layers of the scalp (fig. 306). The skin and subcutaneous tissue of the scalp become thinner as they are traced downwards into the corresponding structures of the temporal region. The only vessels of importance in this region

FIG. 305.—THE ARTERIES OF THE SCALP AND FACE. (*After Merkel.*)



are the superficial temporal, and they lie in the superficial fascia (fig. 306). When the epicranial aponeurosis is traced downwards from the crown, it is seen to be adherent to the temporal ridges and then to form a deep layer of the superficial fascia in the temporal region, becoming adherent to the zygoma below. When the pericranium is traced downwards, it will be found to become intimately adherent to the upper line of the temporal ridge, at which it appears to divide into superficial and deep layers (fig. 306). The superficial layer, which is extremely dense and strong, passes over the temporal muscle to end below at the upper border of the zygoma and malar, thus roofing over the temporal fossa. It divides as it approaches the zygoma, and is attached to both the inner and outer borders of that process. The thin deep layer passes beneath the muscle and serves as the periosteum of the bones which form the floor of the temporal fossa. A window should be made in the deep temporal fascia, and the muscle fibres pushed aside until the depth of the temporal fossa is seen (fig. 306). The student

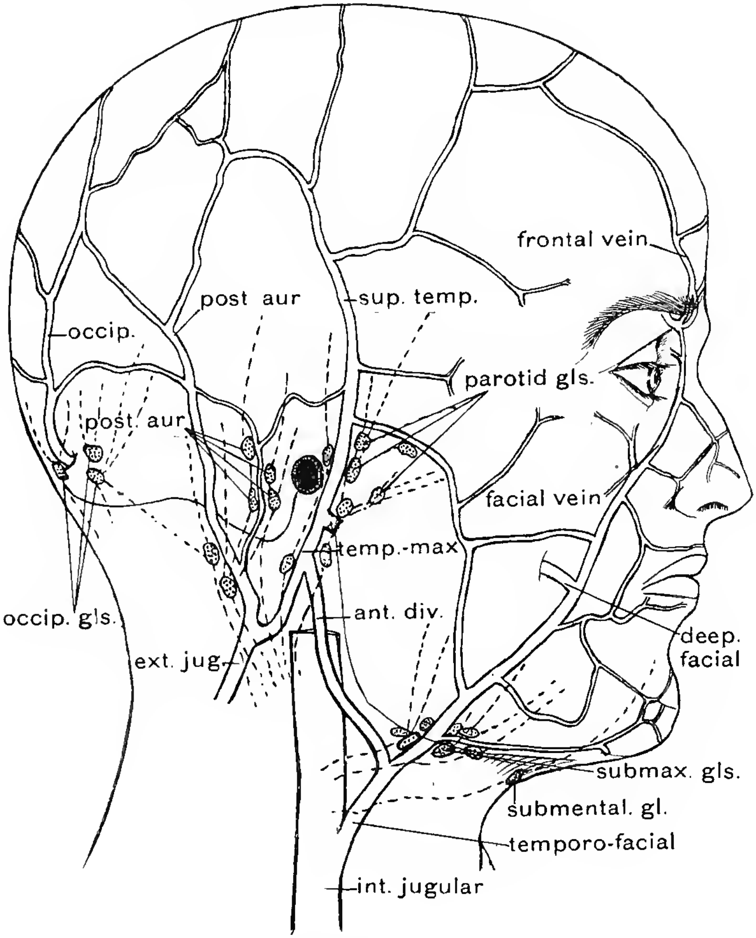
Fig. 306.—Structures in the temporal fossa divided in exposing the temporal lobe.



will have thus obtained a mental picture of the various structures covering the cranium in this region.

Lymphatics of the Scalp.—The *lymphatics* of the frontal segment pass with the facial veins to the group of glands over the submaxillary salivary gland and along the course of the superficial temporal vein to the lymphatic glands lying over the parotid (fig. 307). The student will not be able to distinguish the lymph vessels with the naked eye, but afterwards he will find clinical evidence of their termination in the two groups of glands named.

Fig. 307.—Veins and lymphatic glands of the scalp and face. (*F. W. Jones.*



Dissection of the Parieto-occipital Segments of the Scalp.—In order to examine the structures in the parieto-occipital segments of the scalp, the head and neck must be raised and propped up by blocks. The arteries and nerves which enter these segments of the scalp have been already traced in the dorsal dissection of the neck (fig. 267, p. 7). The upper angle of the segment should be raised in order to re-examine the five layers of the scalp (see p. 9). The skin should be dissected off each segment, so that all the structures are exposed down to the occipital protuberance and mastoid process. A semicircular incision should be made downwards 1½ inches behind the ear, so as to leave the auricular muscles and structures intact.

The following structures are then to be re-examined and followed to their terminations :

THE OCCIPITAL ARTERY.—The artery is best found as it crosses the superior curved line, surrounded by dense tissue, 1½ inches from the external occipital protuberance. It arises from the external carotid artery, and its deep course in the neck has been already seen (fig. 305). Its ramifications should be followed in the scalp, and communications between its branches and those of the posterior auricular artery noted.

The OCCIPITAL VEIN (fig. 307) lies with the artery in the scalp, but its termination is peculiar. Some of its terminal divisions join the deep cervical veins under the complexus muscle, while others join the external jugular. The *mastoid vein*, which connects the occipital vein with the lateral sinus through the mastoid foramen, will be found at the posterior border of the mastoid process, beneath the insertion of the sterno-mastoid muscle. This communication between the deep blood-sinuses of the brain and superficial veins of the scalp is a channel which may serve not only to convey blood but also infection. Assistance in localising its position will be obtained by examining the dried skull.

The GREAT OCCIPITAL NERVE is found crossing the artery at a point 1½ inches from the external occipital protuberance. It is the terminal part of the posterior division of the second cervical nerve, and supplies the greater part of the parieto-occipital segment of the scalp (fig. 267, p. 5).

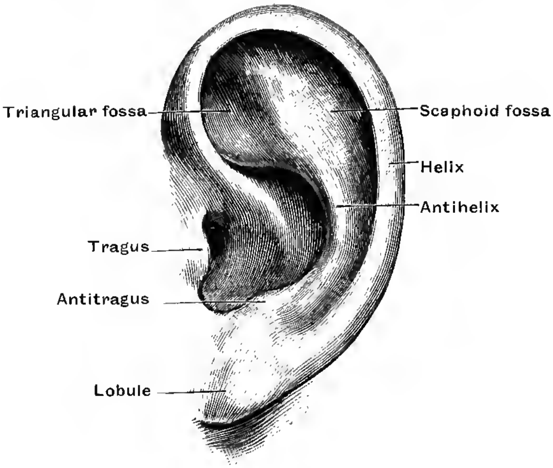
The SMALL OCCIPITAL NERVE (fig. 267, p. 5) passes into the scalp along the posterior border of the sterno-mastoid.

It supplies a small part of the scalp, and sends a branch to the upper part of the ear.

The Occipitalis Muscle (fig. 267, p. 5).—The occipitalis muscle arises from the outer two thirds of the superior curved line, and, after passing upwards as a thin sheet for about two inches, becomes continuous with the epicranial aponeurosis. Its nerve comes from the posterior auricular branch of the facial. Through the epicranial aponeurosis it may retract the scalp, but in most individuals it is only slightly developed and incapable of producing any movement.

The Occipital Lymph Glands (fig. 307).—In the subcutaneous tissue of the neck, along the superior curved line, may be found four or five glands—the occipital group of lymph glands. Normally they are very small, but in affections of the posterior segments of the scalp and in diseases like syphilis they become enlarged and easily felt.

Fig. 308.—External view of the left auricle. (*From Morris's 'Anatomy.'*)



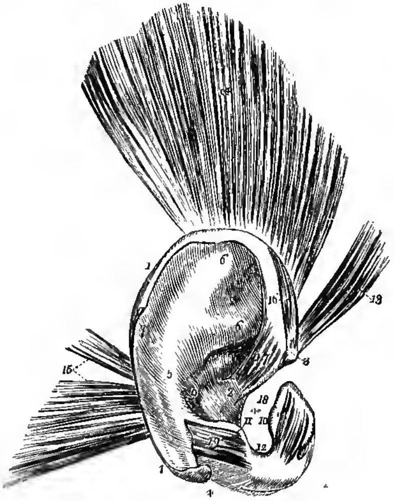
Dissection of the External Ear.—Before proceeding to extract the brain the student should dissect the external ear, and the subcutaneous structures round it, for if this dissection is postponed the part is apt to become dry and useless.

By the help of fig. 308 the student should recognise the following parts of the external ear:—The *Concha*, which acts as a chamber for collecting sounds; in its fundus opens the external auditory meatus; the *Antihelix* bounds the concha behind and above; the *Tragus* and *Antitragus*, separated by the intertragal notch, bound the concha below. The *root of the helix* arises in the upper part of the concha. The *helix* passes first upwards, then bends backwards, to become continuous with the infolded margin of the ear. On the upper part of the margin a tubercle (Darwin's tubercle) will probably be more or less marked. It corresponds to the tip of the common type of mammalian ear. The *lobule* contains no cartilage.

The structure of the ear is best seen by making a section from behind through the free part into the concha. The basis is seen to be made up of a thin plate of yellow fibro-cartilage, to which the skin is bound on each surface by a thin layer of connective tissue containing vessels and nerves.

In order to examine the muscles, vessels, and nerves of the ear, and the parts immediately surrounding it, the skin should be carefully removed. To see the vessels and nerves which supply the ear, the skin over the parotid gland must be raised forwards, and that over the mastoid process backwards.

FIG. 309.—THE PINNA AND ITS MUSCLES. (*Wilson, after Arnold.*)



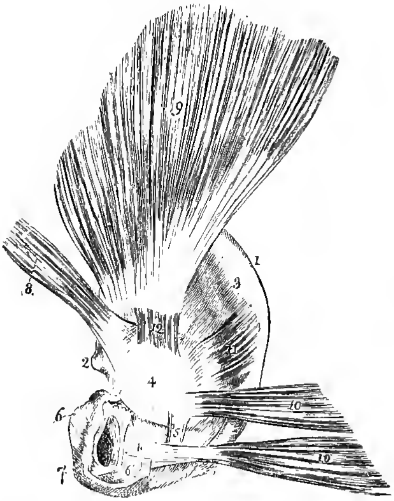
1, 1. Helix. 2. Crus helicis. 3. Spina helicis. 4. Processus caudatus helicis. 5. Antihelix. 6, 6. Crura antihelicis. 7. Fossa scaphoidea or fossa of the helix. 8. Fossa of the antihelix or triangular fossa. 9. Concha. 10. Tragus. 11. Antitragus. 12. Incisura intertragica. 13. Attrahens auriculam. 14. Attollens auriculam. 15. Retrahens auriculam. 16. Major helicis muscle. 17. Minor helicis muscle. 18. Tragicus. 19. Antitragicus.

Extrinsic Muscles of the Ear.—The extrinsic muscles of the ear are to be examined first. They are three in number (see figs. 309, 310):

(1) Retrahens auriculam.
(2) Attollens auriculam.
(3) Attrahens auriculam.

The RETRAHENS AURICULAM is composed of a long superficial and a short deep slip. The superficial muscle arises from the outer end of the superior curved line, frequently in contact with the occipitalis, and is inserted to the cranial aspect of the concha (fig. 310). The deep muscle passes from the mastoid process to the concha. The ATTOLLENS AURICULAM (fig. 309) is made up of scattered fibres, arising from the margin of the epicranial aponeurosis, but converging as they pass downwards to be inserted on the cranial aspect of the antihelix. The ATTRAHENS AURICULAM is not distinctly separated from the attollens. It arises from the superficial temporal fascia above the zygoma, and passes backwards to be inserted to a spine (spina helicis, fig. 309, 3) on the root of the helix. All the muscles of the ear are supplied by the posterior auricular branch of the facial nerve (fig. 311). Although it is only in a small percentage of people that the external muscles have power to move the ear, yet probably they act in all as a physical basis for the reflection of certain mental states.

FIG. 310.—THE PINNA AND ITS MUSCLES, AS SEEN FROM BEHIND. (*Wilson, after Arnold*).



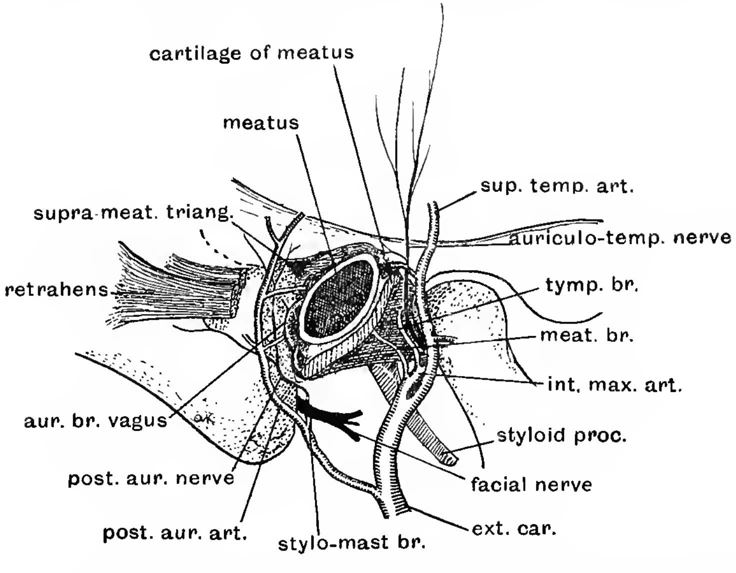
1, 1. Border of the helix. 2. Spine of the helix. 3. Convexity corresponding with the fossa of the helix. 4, 4. Convexity of the concha; the fissure between the numbers corresponds with the crus helicis. 5. Ponticulus conchæ. 6, 6. Cartilage of the meatus. 7. Aperture of the meatus. 8. Attrahens auriculam. 9. Attollens auriculam. 10. Retrahens auriculam. 11. Transversus auriculæ. 12. Obliquus auris.

Intrinsic Muscles of the Ear.—The intrinsic muscles of the ear are pale minute slips of muscle found in the external ear, and apparently capable of producing slight movement of one part of the ear on another. One will be found on the helix (*major helicis*); the *minor helicis* lies on the root of the helix (fig. 309, 17); another slip passes from the antihelix to the antitragus (*antitragicus*, fig. 309, 19), another from the tragus to the helix (*tragicus*). On the back of the ear, spanning the depression between the antihelix and the concha, will be found scattered muscle fibres (*musculus transversus* and *musculus obliquus*; see fig. 310).

Vessels of the Ear.—The chief artery of the ear is the *posterior auricular*, a branch of the external carotid (fig. 311).

If the external ear be pulled forwards and fixed, the artery will be found passing up deeply between the mastoid process and concha. It sends branches to the ear, some of which perforate the concha and ramify beneath the skin on the superficial aspect. The artery is continued to the scalp, anastomosing with the occipital and superficial temporal arteries, and athough it is usually a vessel much smaller than either of these, it may occasionally be found of considerable size and supplanting them to a considerable extent (fig. 305, p. 100). This artery and the structures which lie behind the ear should be noted minutely, as they are involved in the operation which has so frequently to be undertaken in the treatment of middle-ear disease.

FIG. 311.—THE NERVES AND ARTERIES OF THE EXTERNAL EAR AND MEATUS.



The *posterior auricular vein* will be seen to join the external jugular over the sterno-mastoid muscle (fig. 307).

The superficial temporal artery gives off a twig to the helix of the ear (fig. 311).

Nerves of the External Ear.—The *posterior auricular branch* of the facial nerve, which is purely motor, and supplies the muscles of the ear, as well as the occipitalis, will be found beneath the posterior auricular artery, between the mastoid process and concha (fig. 311). It is a fine twig which emerges between the parotid gland and mastoid process. Its terminal twigs should be followed to the auricular and occipitalis muscles.

The terminal part of the *great auricular nerve* supplies the major part of the ear with sensory fibres. The nerve pursues a course marked by a line drawn from the mid-point of the posterior border of the sterno-mastoid to the lobule of the ear and is derived from the anterior primary divisions of the second and third cervical spinal nerves. Below the ear the nerve will be found to divide into three branches: the posterior ends in the tissues over the mastoid; the anterior over the parotid; while the middle ends in the ear (fig. 270, p. 11).

Three other nerves send branches to the outer ear; a twig from the *small occipital* to the upper part of the ear has been already mentioned; so has the twig to the helix from the *auriculo-temporal* (fig. 311); a third, the *auricular branch of the vagus,* is hard to find (fig. 311). It is best to look for it by raising the meatal cartilage forwards and downwards by the handle of the knife and exposing the outer end of the external auditory process. Between the process and the anterior border of the mastoid, as may be seen by referring to the dried skull, the auricular branch of the vagus emerges and passes into the meatus by perforating the meatal cartilage. It is distributed to the meatus and concha on their inner aspects. Foreign bodies in the meatus may irritate the vagal centres in the medulla through this twig and give rise to a cough.

Posterior Auricular Lymph Glands (fig. 307).—Two or three small lymph glands are situated over the mastoid process and behind the ear. They receive lymph-vessels from the external ear, meatus, and that part of the scalp supplied by the posterior auricular artery, and become enlarged in affections of these parts.

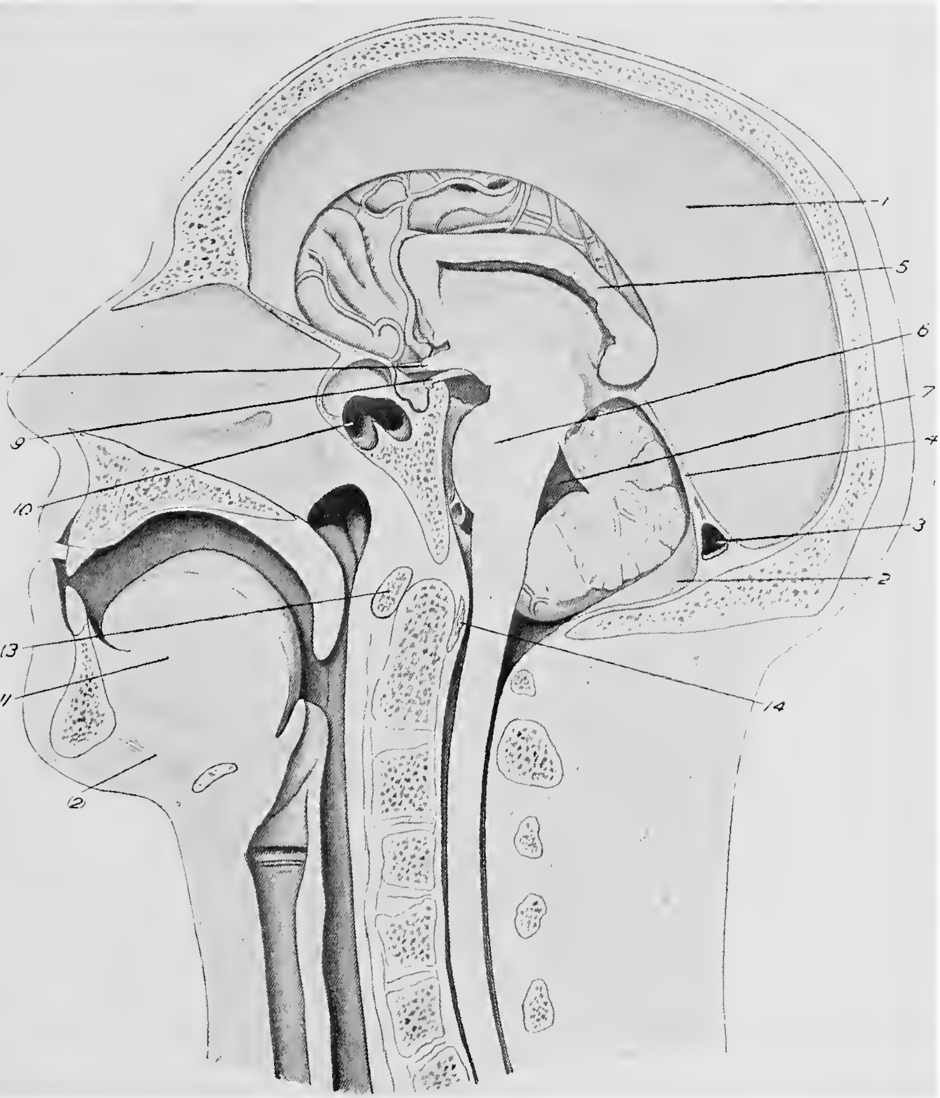
THE REMOVAL OF THE BRAIN

The subject remains placed on its back, with the head propped up by a block. The brain should be removed in the following stages.

First.—All the soft structures covering the roof of the skull above the supra-orbital margin in front, the external

PLATE XLVIII

A MESIAL VERTICAL SECTION OF THE HEAD AND NECK. (*Hughes.*)



1. Falx cerebri. 2. Falx cerebelli. 3. Torcular Herophili. 4. Tentorium cerebelli. 5. Corpus callosum. 6. Pons Varolii. 7. Fourth ventricle. 8. Optic chiasma. 9. Infundibulum. 10. Sphenoidal sinus. 11. Genio-hyo-glossus. 12. Genio-hyoid. 13. Anterior arch of atlas. 14. Transverse ligament of atlas.

occipital protuberance behind and to a corresponding level at the sides, are to be cleared off with a blunt chisel. The sagittal, coronal, and lambdoidal sutures, to which the pericranium is tightly bound, should be traced. The origin of the deep temporal fascia from the temporal ridges is to be raised by the knife, and the temporal muscle pushed downwards to the required level.

SECOND.—The roof of the skull is removed by a saw. To serve as a guide, the student should tie a piece of string round the skull, passing it half an inch above the external occipital protuberance behind and the supra-orbital margin in front. The cut should pass along the upper margin of the string. The skull is thick in the frontal and occipital regions, and comparatively thin at the sides. When the circular cut is complete the calvarium may be best separated from its attachments to the dura mater by prizing it with a chisel.

THIRD.—The dura mater, the outer of the three membranes of the brain, is now exposed, but before cutting it, so as to lay bare the brain, covered by the arachnoid, the student should note the following points:

(1) PACCHIONIAN BODIES projecting on the surface of the dura mater at each side of the superior longitudinal sinus. The bodies are lodged in minute fossæ in the overlying skull-bones. As may be seen from fig. 303 (p. 95), the Pacchionian bodies are really villous processes of the arachnoid projecting within lateral lacunæ of the longitudinal sinus. Through them the cerebro-spinal fluid passes from the subarachnoid spaces into the venous sinuses.

(2) The FRONTAL SINUSES laid open in the frontal bone over the orbits (Plate XLVII, p. 98). They open in the middle meatus of the nose.

(3) The anterior and posterior divisions of the MIDDLE MENINGEAL ARTERY (fig. 318, p. 120) lying on the dura mater and grooving the under surface of the parietal bone. The main branches of the anterior division lie beneath the anterior third of the parietal bone.

The dura mater is then to be reflected in the following manner:—Cut the dura mater open with scissors from front to back, along each side of the superior longitudinal sinus. Divide the dura mater vertically, so that it may be thrown downwards on each side as two triangular flaps. Separate the hemispheres of the brain slightly in front, and cut through the *falx cerebri* at its attachment to the crista galli (Plate XLVIII). As it is lifted upwards, the terminations of the cerebral veins in the longitudinal sinus are cut through. The falx cerebri becomes deeper as it passes backwards and terminates behind on the upper surface of the tentorium cerebelli, a horizontal plate of dura mater which separates the occipital lobes of the brain above from the cerebellum below (Plate XLVIII). The hemispheres of the brain are now exposed, wrapped in their coverings of arachnoid and pia mater.

Before proceeding to the fourth stage in the removal of the brain, the dissector should note the following points concerning the connection between the brain and its covering:

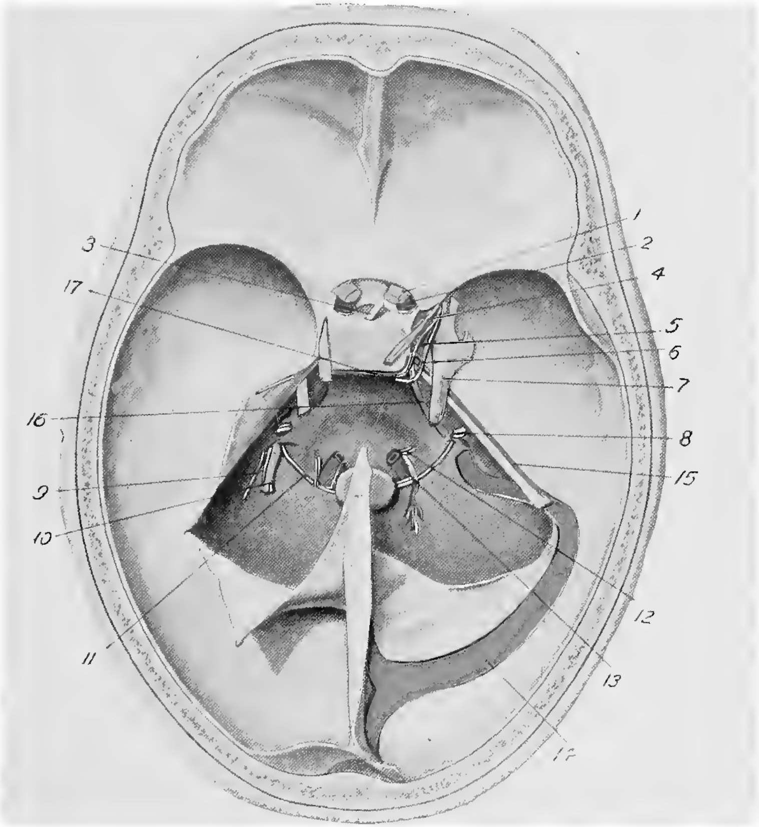
(1) The SUB-DURAL SPACE (fig. 303, p. 95).—Probably the student will notice, as he reflects the dura mater, that there is a considerable space between it and the underlying arachnoid. This is an artificial space caused by post-mortem shrinkage of the brain. In life the brain completely fills the cranial cavity so that the outer smooth surface of the arachnoid is pressed closely against the inner smooth surface of the dura mater. The sub-dural is a potential space in which collections of blood or pus may form and compress the underlying brain. Except at the entrance of the cerebral veins into the superior longitudinal sinus and at the attachments of Pacchionian bodies, the dura mater and the arachnoid are freely separable from each other on the upper aspect of the brain.

(2) The SUPERIOR CEREBRAL VEINS which receive blood from the upper half of the cerebral cortex and enter the superior longitudinal sinus, turning forwards as they enter. The veins from the lower part of the occipital lobe will be found to open into the lateral sinus. A vein leaves the frontal lobe to join a small sinus below the lesser wing of the sphenoid. The vein over the fissure of Sylvius, which ends in the cavernous sinus, is in direct communication with a superior cerebral vein over the anterior part of the parietal lobe. A communication is thus opened up between the superior longitudinal sinus and the cavernous sinus.

FOURTH STAGE.—The head must be allowed to fall backwards until the frontal lobes begin to fall from the anterior fossa of the skull. The student should have by him the base of a skull to guide him as to the position of the various structures he has now to cut through. Reference to Plate

PLATE XLIX

BASE OF THE SKULL AFTER REMOVAL OF THE BRAIN. THE VENOUS SINUSES AND INTRA-CRANIAL STAGES OF THE CRANIAL NERVES ARE SHOWN. (*Hughes.*)



1. Optic nerve. 2. Internal carotid artery. 3. Infundibulum. 4. Third nerve. 5. Fourth nerve. 6. Sixth nerve. 7. Root of fifth nerve. 8. Seventh and eighth nerves. 9. Ninth (Glossopharyngeal) nerve. 10. Tenth (Vagus) nerve. 11. Eleventh (Spinal accessory) nerve. 12. Twelfth (Hypoglossal) nerve. 13. Vertebral artery. 14. Lateral sinus. 15. Superior petrosal sinus. 16. Inferior petrosal sinus. 17. Basilar sinus.

XLIX will also assist him. The structures divided in removing the brain are:

(1) THE OLFACTORY TRACTS.—As the orbital surfaces of the frontal lobes are lifted from the roofs of the orbits, the olfactory bulbs are seen, situated on the cribriform plates; the tracts are cut behind the bulbs which are thus left in position.

(2) The OPTIC NERVES, as they leave the skull by the optic foramina.

(3) The INTERNAL CAROTID ARTERIES, as they emerge from the cavernous sinuses behind the optic nerves and pierce the arachnoid membrane. As the frontal lobes are lifted the temporal lobes will be observed to fill the middle fossa of the skull, their anterior poles lying under the small wings of the sphenoid. A cerebral vein, as it enters the sinus of the small wing, may also require to be cut.

(4) The INFUNDIBULUM of the PITUITARY BODY, lying between and behind the carotid arteries (Plate XLVIII, p. 108).

(5) The THIRD PAIR of CRANIAL NERVES as they enter the outer wall of the cavernous sinus.

(6) The FOURTH PAIR of NERVES, behind and external to the third pair (fig. 316, p. 118).

(7) The attachment of the TENTORIUM CEREBELLI to the upper border of the petrous bone. To complete the division of the tentorial attachment, it is necessary to replace the brain in the skull and, by lifting up the occipital lobe at the side, expose and divide its attachment to the occipital, parietal and mastoid parts of the skull on each side (see Plate XLIII, p. 10).

(8) The GREAT VEIN of GALEN (fig. 432, p. 303). This vein will be found between the hemispheres, emerging from beneath the posterior end of the corpus callosum and running backwards to join the straight sinus at the anterior border of the tentorium. It returns the blood from the ventricles of the brain.

(9) The FIFTH PAIR of NERVES. They are seen when the frontal lobes of the brain are again raised, passing from the pons outwards below the attached border of the tentorium (Plate XLIX).

(10) The SIXTH PAIR of NERVES, perforating the duramater near the middle line in the posterior fossa.

(11) The SEVENTH and EIGHTH PAIRS are cut together

as they enter the internal auditory meatus (Plate LIII, D, E, p. 244).

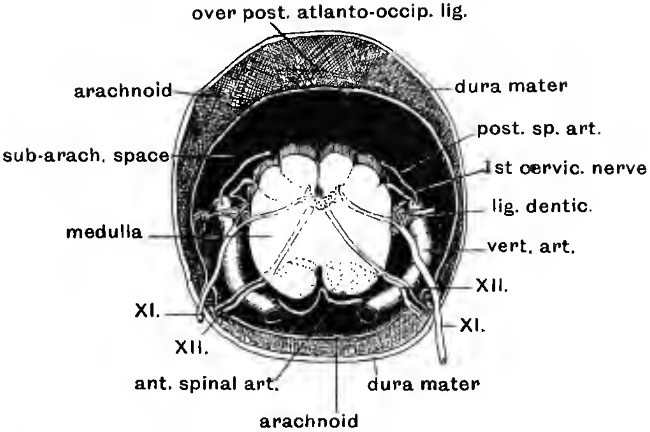
(12) The NINTH, TENTH, and ELEVENTH PAIRS are cut as they perforate the dura-mater at the jugular foramina (Plate XLIX, p. 110).

(13) The TWELFTH PAIR are cut as they pass out at the anterior condylar foramina (Plate XLIX).

(14) The ARACHNOID forming a thin funnel-shaped sheath round the medulla and spinal cord in the foramen magnum (fig. 312).

(15) The VERTEBRAL ARTERIES as they pass forwards in the foramen magnum to form the basilar artery (fig. 312).

FIG. 312.—A DIAGRAM OF THE STRUCTURES WITHIN THE FORAMEN MAGNUM.



(16) The SPINAL CORD is divided at the lower margin of the foramen magnum by a sharp scalpel. At the same time the spinal arteries and the pia mater are divided (fig. 312).

Subarachnoid Spaces at the Base of the Brain (see fig. 434, p. 307).—The brain is then free and may be removed, but before being put away in methylated spirits for future examination, certain features of the sub-arachnoid spaces at the base of the brain should be noted.

The CISTERNA BASALIS.—The internal carotid arteries perforate the arachnoid, and, in the space within the membrane (cisterna basalis), break up to join with branches of the basilar in forming the circle of Willis (fig. 434, p. 307). In the normal condition the arachnoid covering this space is a thin translucent membrane stretching from the temporal lobe of one side to the temporal lobe of the other. The space contains clear cerebrospinal fluid. But when the membrane becomes inflamed, as in meningitis, the arachnoid becomes opaque and the space may be filled with pus. Offshoots of the cisterna basalis can be traced into the Sylvian fissure on each side, into the great longitudinal fissure in front, and backwards below the pons and medulla in the cisterna pontis, which encloses the basilar artery. The cisterna pontis becomes continuous with the cisterna magna, a dilatation of the subarachnoid space continuous with that in which the spinal cord is suspended (fig. 432, p. 303).

Contents of the Foramen Magnum (fig. 312).—The spinal part of the subarachnoid space may be well seen at present by examining the contents of the foramen magnum. The cut end of the spinal cord, the spinal roots of the spinal accessory nerves, and the vertebral arteries lie within the subarachnoid space. The arachnoid membrane, which is bound closely to the convolutions of the brain, is here separated from the cord by a wide space. It will be at once apparent to the student that the cerebro-spinal fluid, in the great basilar subarachnoid spaces, is in continuity with the fluid in the subarachnoid space round the spinal cord, and that it would be possible to drain these spaces by tapping the subarachnoid cavity in the lumbar region of the spinal column. Having made these observations, the student may put the brain away to be studied when he has finished the dissection of his part.

Removal of the Spinal Cord.—The spinal canal is now to be opened and its contents examined. The procedure to be adopted is described in full under the anatomy of the spinal cord (see Dissection XXII, p. 289). When removed, the cord is put away with the brain for future examination. While removing the cord, the student must see that the base of the skull is protected, otherwise it will become desiccated and difficult of dissection.

DISSECTION VIII

STRUCTURES SEEN IN THE BASE OF THE SKULL AFTER THE REMOVAL OF THE BRAIN

It is better to proceed as soon as possible with the examination of the structures seen within the skull after the brain is removed, for if the matter be deferred, as is customary, the many important structures at the base of the brain become less distinctly marked and more difficult of dissection.

The **Dura Mater** forms the outer membranous envelope of the brain and lines the skull (fig. 303, p. 95). At the foramen magnum it is prolonged within the spinal canal to form the outer sheath for the cord; at the sphenoidal fissure it passes within the orbit and becomes continuous with the periosteum lining that cavity. Each pair of cranial nerves carries prolongations of the dura mater which are continuous with their sheaths as they emerge from the skull.

The dura mater is composed of two layers firmly welded together; an outer *periosteal* layer containing the meningeal vessels and nourishing the overlying cranial bones, and an inner *supporting* layer. The cerebral venous sinuses are formed by the separation of these two layers (fig. 303, p. 95). The supporting layer is folded in between the cerebral hemispheres to form the FALX CEREBRI (Plate XLVIII, p. 108); between the cerebrum and cerebellum to form the TENTORIUM CEREBELLI, and between the lateral lobes of the cerebellum to form the slightly marked FALX CEREBELLI.

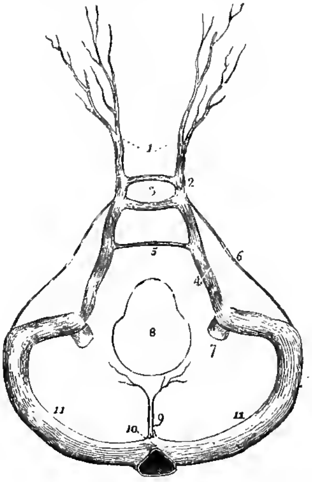
The **Tentorium Cerebelli** (see Plate XLVIII, p. 108 and Plate XLIX) is particularly worthy of notice. When replaced *in situ*, the cerebellar compartment of the cranial cavity is seen to communicate with the cerebral compartment by the *tentorial passage* which contains the peduncles of the brain and basilar artery (fig. 316). The tentorium slopes rapidly downwards and outwards from its attachment to the falx cerebri. Its free border, bounding the passage, is continued forwards to the anterior clinoid processes, while the border fixed to the petrous bone will be noticed to pass under it and become attached to the posterior clinoid processes. As the borders cross they form the apex of a triangle (fig. 316) which may be called the *oculomotor triangle*, as the third nerve perforates the dura mater at its centre. The fourth nerve pierces the dura mater at its apex.

The dura mater is easily detached from the bones over the vault of the skull, except at the sutures, but on the base it is not easily separated from the underlying bones.

Venous Sinuses within the Skull.—The cerebral veins terminate in blood sinuses situated between the two layers of the dura mater. Such stout-walled venous chambers are required within the skull to withstand the intra-cranial arterial blood-pressure. The following sinuses should be examined :

(1) SUPERIOR LONGITUDINAL SINUS (fig. 314).—It is triangular in section and crossed here and there by minute fibrous cords (cords of Willis, fig. 303, p. 95). Lateral lacunæ or recesses open from it to surround groups of Pacchionian bodies. The *parietal vein*, which perforates the parietal bone at each side of the sagittal suture about two inches from its posterior end, brings the sinus into communication with the veins of the scalp. The parietal veins, however, are frequently absent. The superior longitudinal sinus runs along the attached margin of the falx cerebri. It commences as quite a small channel at the crista galli, where it may be joined by a nasal vein, and enlarging as it passes backwards, terminates beneath the external occipital protuberance in the torcular Herophili. It receives the upper cerebral veins.

FIG. 313.—A DIAGRAM OF THE SINUSES ON THE BASE OF THE SKULL. (*Wilson.*)



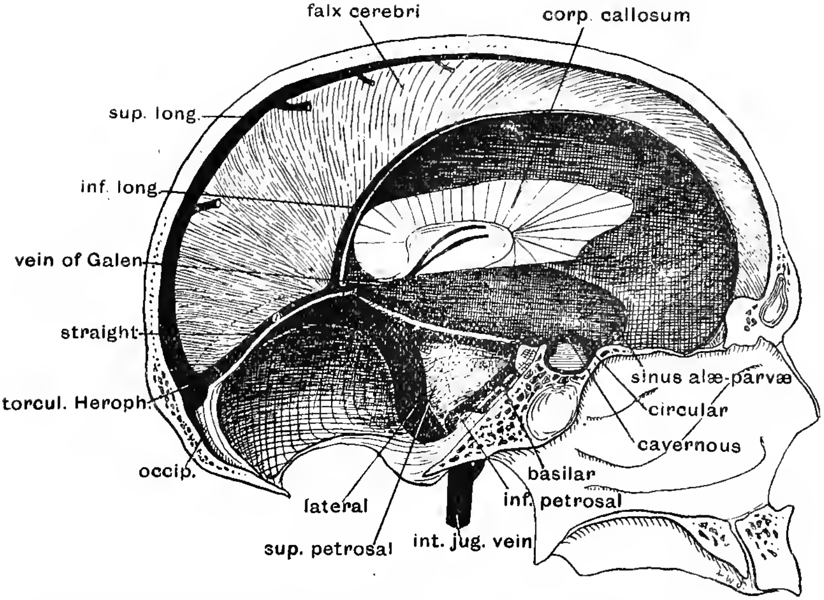
1. Ophthalmic veins. 2. Cavernous sinus of one side. 3. Circular sinus: the figure occupies the position of the pituitary gland in the sella turcica. 4. Inferior petrosal sinus. 5. Transverse sinus. 6. Superior petrosal sinus. 7. Internal jugular vein. 8. Foramen magnum. 9. Occipital sinuses. 10. Torcular Herophili. 11, 11. Lateral sinuses.

The TORCULAR HEROPHILI (fig. 314, p. 116) is a posterior dilatation of the longitudinal sinus, and is situated at the junction of the falx cerebri and tentorium cerebelli. As a rule it lies to the right side of the external occipital protuberance and ends chiefly in the right lateral sinus. A small sinus—the *occipital*—lies in the falx cerebelli, and connects the torcular with the vertebral veins round the foramen magnum.

(2) The INFERIOR LONGITUDINAL SINUS (fig. 314) is of small size and runs along the inferior border of the falx cerebri. It terminates in the straight sinus.

(3) The STRAIGHT SINUS (fig. 314) receives the blood from the inferior longitudinal sinus and from the cerebral ventricles by the great vein of Galen. It passes backwards in the junction of the falx cerebri and tentorium cerebelli, and ends in the torcular Herophili or, more commonly, in the lateral sinus of the left side.

FIG. 314.—THE INTRACRANIAL VENOUS SINUSES. (*F. W. Jones.*)

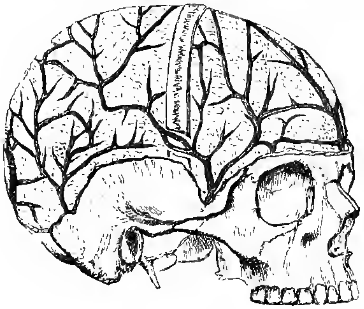


(4) LATERAL SINUS.—The blood in the torcular Herophili is conveyed to the internal jugular vein by the lateral sinuses. They pass outwards on the occipital bone and posterior inferior angle of the parietal in the attached margin of the tentorium cerebelli (Plate XLIX, p. 110). They reach their highest point at the asterion, and then turn downwards beneath the mastoid (fig. 302, p. 92). They cross the jugular process of the occipital and end in the internal jugular vein within the large

posterior segment of the jugular foramen. Cerebral veins from the occipital lobe, and cerebellar veins, end in it. The *mastoid vein* (an emissary vein) connects it with the occipital veins. Near its termination the lateral sinus is united with the occipital veins by the posterior condylar vein. As the lateral sinus turns down on the mastoid it receives the small *petro-squamosal sinus.* This sinus, of variable size, passes backwards in the depression which marks the union of the petrous and squamous parts of the temporal bone. It receives tributaries from the middle ear, and in disease of that part may be the means by which infection spreads to the lateral sinus. In such cases the lateral sinus may have to be opened behind the ear, hence the student should note closely its surface relationships. It passes vertically downwards, $\frac{3}{4}$ inch behind the external auditory meatus, its upper end being $\frac{3}{4}$ inch at least above the level of the meatus (fig. 302, p. 92).

(5) CAVERNOUS SINUS.—The cavernous sinus lies on the body of the sphenoid, between the sphenoidal fissure in front and the apex of the petrous bone behind (fig. 336, p. 151). On transverse section the sinus is seen to be triangular in shape and divided into numerous spaces by a fibrous network (fig. 317). On its outer sloping wall are imbedded the third, fourth, and fifth nerves; within it are the internal carotid artery and sixth nerve. The upper and lower ophthalmic veins open into it in front; the superior and inferior petrosal and basilar sinuses pass from it behind (fig. 336). The right and left sinuses are connected by the CIRCULAR SINUS which surrounds the pituitary body. Into the cavernous sinus open the superficial Sylvian vein from the cortex and the SINUS ALÆ PARVÆ, along the posterior border of the small wing of the sphenoid (fig. 314).

FIG. 315.—THE EXTERNAL TABLE OF THE SKULL REMOVED TO SHOW THE VEINS OF THE CRANIAL DIPLOË. (*Wagstaffe.*)



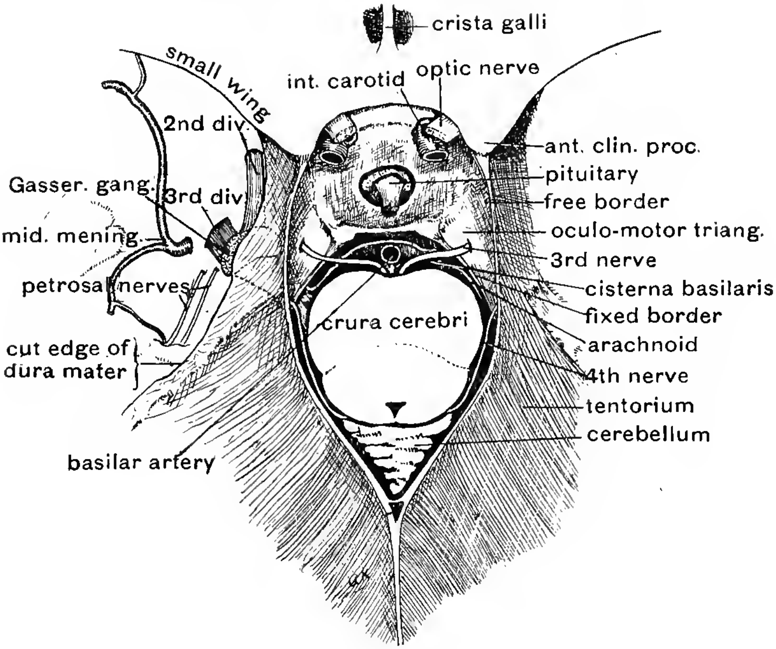
(6) The SUPERIOR PETROSAL SINUS (fig. 314) passes along the margin of the tentorium cerebelli attached to the upper

border of the petrous bone and opens into the lateral sinus. It crosses the root of the fifth nerve.

(7) The INFERIOR PETROSAL SINUS passes backwards between the petrous bone and basi-occipital and leaves the skull by the small anterior compartment of the jugular foramen (fig. 314). It joins the internal jugular vein half an inch below its point of exit.

(8) The BASILAR or TRANSVERSE SINUS (fig. 314) can be seen on making a section through the dura mater covering the basi-sphenoid and basi-occipital. It receives tributaries from the cavernous and inferior petrosal sinuses, and branches from it pass through the foramen magnum to join the intra-spinal plexus of veins.

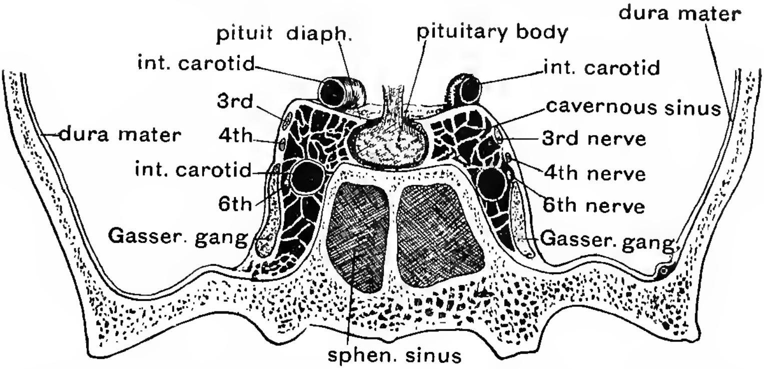
FIG. 316.—THE OCULO-MOTOR TRIANGLE AND THE PASSAGE IN THE TENTORIUM CEREBELLI OCCUPIED BY THE CRURA CEREBRI.



Meningeal Vessels.—As he dissects his part, the student is very apt to forget that the cranial bones and the dura mater, in the subjects he has to deal with in practice, are composed of actively living tissues requiring an ample supply of nourishment. This, he should remember, is brought to them by the meningeal arteries. Of these he must now examine the following:

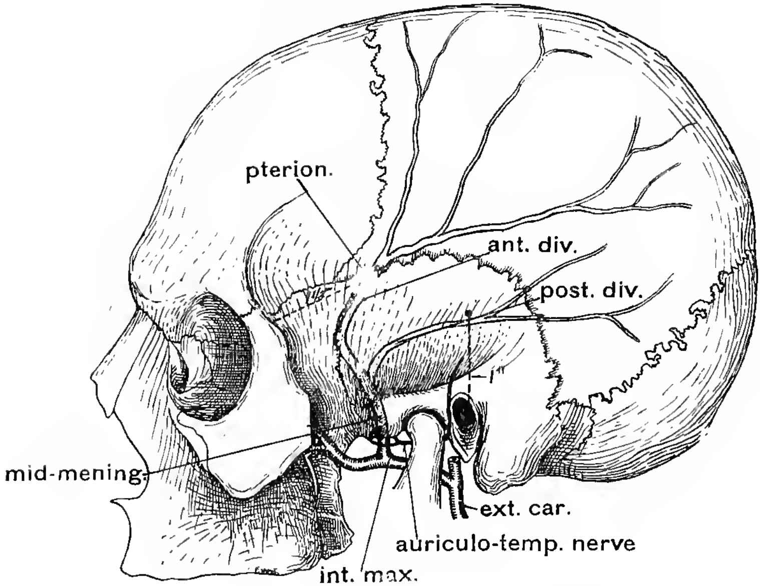
(1) Middle Meningeal Artery.—This is by far the chief of the meningeal vessels, and a knowledge of its position and distribution is important to the surgeon. It springs from the internal maxillary artery, and will be found entering the middle fossa at the foramen spinosum (fig. 318). As it passes outwards on the great wing of the sphenoid, it divides into a large *anterior* and a small *posterior* division. The anterior division passes beneath the parietal bone at its anterior inferior angle, and is distributed to the anterior two thirds of the parietal and posterior part of the frontal and the underlying dura mater (fig. 318). The anterior division is frequently torn in fractures of the skull which involve the bones covered by the temporal muscle. The cranial bones here are thin, and the artery lies in a groove or canal in the bone. The fixation of the dura to the bones is such that the escape of blood from the artery detaches it, and a collection of blood is formed between the dura and bone, which quickly causes compression of the brain. The anterior inferior angle of the parietal, the usual point of rupture, lies about 1¼ or 1½ inches behind and slightly above the level of the external angular process of the frontal.

Fig. 317.—Transverse vertical section of the body of the sphenoid, pituitary body, and cavernous sinuses. (*Diagrammatic.*)



The student should note that the dura mater requires considerable force to detach it from the middle fossa of the skull. The posterior division sends a small branch to the facial nerve and tympanum through the hiatus Fallopii, then passes backwards on the squamous part of the temporal, an inch above the external auditory meatus, and ends on the posterior part of the parietal and upper part of the occipital bones (fig. 318). The size and point of origin of the posterior division are variable. The middle meningeal artery thus supplies the middle fossa of the skull and lateral part of the calvarium, the dura mater and inner tables being dependent on it for their blood supply.

Fig. 318.—The course and divisions of the middle meningeal artery. (*F. W. Jones.*)



(2) Middle Meningeal Veins.—The artery is accompanied by venæ comites, which pass out by the foramen spinosum and foramen ovale to join the pterygoid plexus of veins.

The other Meningeal Arteries are small twigs derived from the following vessels :

(*a*) From the ethmoidal arteries as they cross the cribriform plate.

(*b*) From the recurrent branch of the lachrymal, which enters at the outer angle of the sphenoidal fissure and communicates with the middle meningeal.

(*c*) From a small branch of the internal maxillary, which enters by the foramen ovale.

(*d*) From minute branches of the ascending pharyngeal, which enter through the jugular and anterior condylar foramina.

(*e*) From the vertebral arteries as they appear in the foramen magnum.

(*f*) From a branch of the occipital which enters at the mastoid foramen.

Veins of the Diploë.—Four such veins can usually be recognised on each side of the skull. They are (see fig. 315):—(1) frontal; (2) anterior temporal; (3) posterior temporal; (4) occipital.

They are important clinically, as channels by which infection may spread, but as the external table of the cranial bones requires to be removed in order to obtain a view of them, it will be evident that more labour and time are entailed than students can afford to give. The *frontal* diploic vein may be found as it escapes to join the frontal at the supra-orbital notch. It receives blood from the greater part of the frontal bone and frontal sinus (fig. 315). The *anterior temporal* diploic vein drains the blood from the bones forming the temporal fossa; it ends either in the sinus of the lesser wing of the sphenoid or in a deep temporal vein. The *posterior temporal* diploic vein ends in the lateral sinus and drains the posterior part of the parietal bone. The *occipital* diploic vein is confined to the occipital bone, and may end either in the torcular Herophili or the occipital vein.

The Gasserian Ganglion and the Three Divisions of the Fifth Nerve.—Recent developments in surgery have given increased importance to the position and intra-cranial relationships of the ganglion and divisions of the fifth cranial nerve. In cases where the fifth nerve is the seat of intractable and unbearable neuralgia, the only effective, although crude treatment, at present appears to be the removal of the Gasserian ganglion. The surgeon obtains access to it by opening the skull above the zygoma, lifting the dura mater and the overlying temporal lobe off the great wing of the sphenoid, and thus exposing the second and third divisions of the fifth nerve (fig. 306, p. 101). If the student will imitate this procedure by seizing the free cut edge of the dura mater on the outer wall of the middle fossa with his forceps and raising it inwards, he will observe that the middle meningeal artery comes directly in the line of operation. As the dura mater is raised inwards the second and third divisions of the fifth nerve are brought into view, as they escape at the foramen rotundum and foramen ovale (fig. 316, p. 118). If he follows these two roots inwards and backwards they guide him to the Gasserian ganglion, about the size of a flattened horse-bean, imbedded in the dura mater on the outer wall of the cavernous sinus, and resting, in part, on a depression at the apex of the petrous bone (fig. 317). The first or ophthalmic division passes forwards to the orbit in the outer wall of the cavernous sinus. The ganglion lies in a cavity of the dura mater (cavum Meckelii). The nerve roots enter the space beneath the edge of the tentorium cerebelli and superior petrosal sinus, carrying a prolongation of the arachnoid into the cavum Meckelii. Under the large sensory root, which was developed from the cells of the ganglion, lies the small motor root passing under the ganglion to the third division, and supplying the muscles of mastication. It will be observed that the motor root may be left intact when the ganglion is excised.

As the internal carotid artery escapes from the petrous bone to the cavernous sinus, it lies beneath and almost in contact with the Gasserian ganglion (fig. 317). Through the three divisions of the fifth, the Gasserian ganglion is brought into sensory relationship with all the structures of the head and face lying in front of the vertical inter-auricular plane.

The *Great and Small Superficial Petrosal Nerves* escape from the hiatus Fallopii on the anterior surface of the petrous bone (fig. 316). They pass forwards beneath the dura mater, and escape between the petrous bone and great wing of the sphenoid. They connect the geniculate ganglion of the facial and tympanic plexus with the spheno-maxillary ganglion (by the great superficial petrosal nerve) and otic ganglion (by the small superficial petrosal).

Points of Exit of the Cranial Nerves.—The manner in which the cranial nerves make their escape from the skull may be quickly studied. The escape of the three divisions of the fifth nerve has just been seen. The student will find it convenient to have the base of a skull by him for reference.

(1) The *Olfactory Nerves* are seen escaping at the foramina

of the cribriform plate, when the olfactory bulb is lifted upwards. As is the case with all cranial nerves, their sheaths appear to be prolongations of the cerebral membranes. Through the nerve-sheaths the lymphatic system of the nasal cavity is brought into communication with the sub-dural and sub-arachnoid spaces of the brain, and by these channels infection may be conveyed from the nasal cavities to the membranes of the brain. Crossing the cribriform plate, the student should note the posterior and anterior ethmoidal arteries, the latter being accompanied by the nasal nerve; they pass thus from the orbit to the nose.

(2) The *Optic Nerves*, surrounded by a stout outer sheath formed of dura mater and arachnoid, are seen to escape at the optic foramina (Plate XLIX, p. 110). A prolongation of the sub-arachnoid space round the optic nerve can be followed to the eyeball. The sub-arachnoid spaces of the two nerves are in communication with each other at the optic chiasma, and through this channel it is possible, although not probable, that infection may spread from one eye to the other, as in the case of sympathetic ophthalmia. The internal carotid arteries turn up behind the optic nerves, giving off their ophthalmic branches, which make their exit by the optic foramina beneath and outside the optic nerve.

(3) The *Third Nerve* enters the dura mater in the centre of the oculo-motor triangle (fig. 316), and is to be followed forwards to the orbit on the outer wall of the cavernous sinus. The third, fourth, sixth and ophthalmic division of the fifth, enter the orbit by the sphenoidal fissure.

(4) The *Fourth Nerve* enters the dura mater at the apex of the oculo-motor triangle (fig. 316, p. 118), passes forwards on the outer wall of the cavernous sinus, and ends in the superior oblique muscle within the orbit.

(5) The *Sixth Nerve* perforates the dura mater in the posterior fossa by the side of the dorsum sellæ; it passes forwards on the outer side of the internal carotid artery, within the cavernous sinus. Within the orbit it supplies the external rectus.

(6) The *Seventh (Facial) and Eighth (Auditory) Nerves*, with a small fasciculus between them (the *pars intermedia*), enter the internal auditory meatus. A tubular prolongation of the dura mater and arachnoid surrounds them in the meatus.

The internal auditory artery, a branch of the basilar, accompanies the nerves (Plate LIII, p. 244).

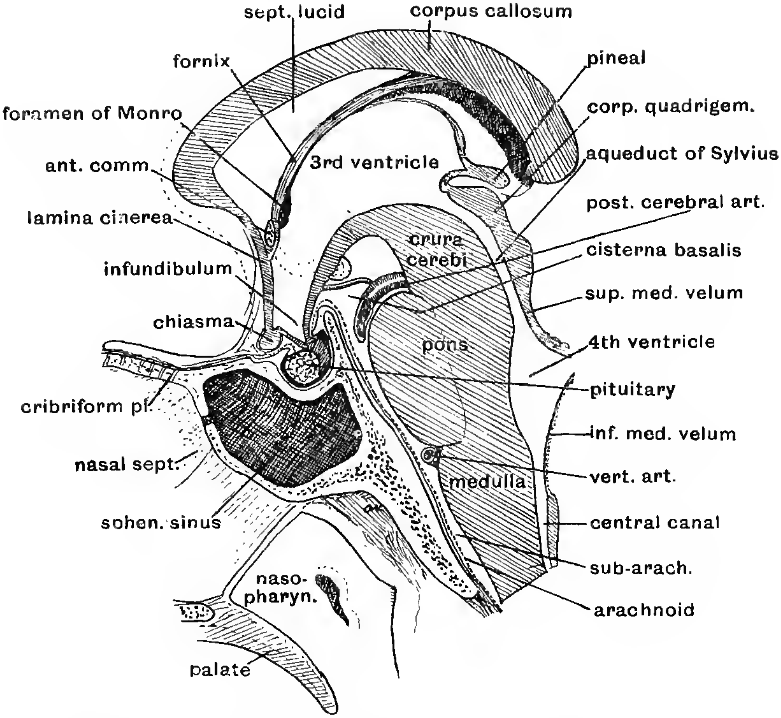
(7) The *Ninth, Tenth, and Eleventh Nerves* (Plate LIII, p. 244) pass out by the jugular foramen, in front of the jugular vein, but behind the inferior petrosal sinus. It will be observed that while the tenth (vagus) and eleventh (spinal accessory) perforate the dura mater together, the ninth (glosso-pharyngeal) passes out by a separate opening in front of them.

(8) The *Twelfth Nerve* (hypoglossal) perforates the dura mater in two separate bundles, and leaves the skull by the anterior condylar foramen.

Pituitary Body (fig. 319).—For clinical purposes it is important to note the position and relationship of the pituitary body. The infundibulum, which connected it with the floor of the third ventricle, was cut in removing the brain. Its extraction from the *sella Turcica* of the sphenoid is difficult, because the supporting layer of the dura mater surrounds its stalk with a circular resisting diaphragm (fig. 316). As a rule it is possible to distinguish the anterior part, of buccal origin, from the posterior or cerebral part, to which the infundibulum is attached (fig. 319). If the pituitary body become enlarged by malignant or other growth, it presses laterally on the cavernous sinus and the important structures in and around it, while just above and in front of it are the optic chiasma and optic tracts (figs. 317, 319). The new growth may spread downwards and fill the sphenoidal sinus. When he has removed the pituitary, the student should chip through the thin floor of the sella Turcica and examine the sphenoidal sinus and its opening in the posterior part of the roof of the nasal cavity.

Internal Carotid Artery.—The cavernous sinus should be freely opened, and the internal carotid artery followed from the point at which it leaves its canal in the petrous bone till it perforates the dura mater behind the optic nerve and anterior clinoid processes (fig. 316, p. 118). The sixth nerve will be seen passing along its outer side. Forming a network, mostly on its inner aspect, will be found the *cavernous plexus*, derived from the upper cervical ganglion of the sympathetic (fig. 413, p. 268). Twigs from the cavernous and carotid plexuses communicate with the surrounding cranial nerves, and some pass directly to the ciliary ganglion within the orbit. If the artery be cut through at its exit from the petrous bone and raised, it will be found to rest on the fibrous tissue in the foramen lacerum medium, over the Eustachian tube. Beneath it, to its outer side, the great superficial petrosal nerve passes forwards. Within the cavernous sinus the internal carotid artery is protected from the pressure of the overlying brain. The uncus of the hippocampal gyrus lies over the cavernous sinus.

Fig. 319.—Vertical mesial section to show: (1) the two parts of the pituitary body; (2) the third ventricle; (3) the cisterna basalis; (4) the sphenoidal sinus.



Relations of the Temporal Bone to the Brain.—One other important point the student should note before he replaces the skull-cap and fixes the scalp back in position, viz. the impressions which the convolutions of the temporal lobe of the brain have made on the temporal bone. On the inner aspect of the squamosal, he will observe from above downwards the distinct impressions of the first and second temporal convolutions;

then on the outer part of the anterior aspect of the petrous, over the middle ear, the impression of the third temporal convolution, and it will at once be apparent to him why this part of the brain should be so frequently the seat of the cerebral abscess which follows as a sequela of chronic middle-ear disease. The posterior aspect of the petrous bone is in contact with the cerebellum and lateral sinus.

DISSECTION IX

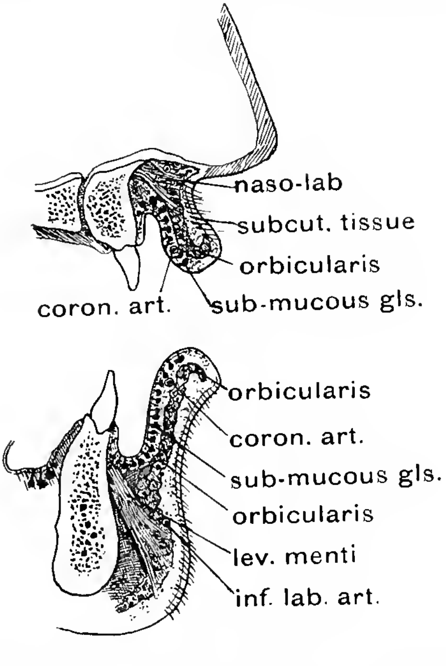
THE DISSECTION OF THE FACE

The **Lower Lip** is so frequently the seat of cancer and other affections which require surgical interference that it is necessary to obtain a correct conception of its structure. There is no better way of doing this than by splitting it vertically open, right down to its attachment to the chin, a little to one side of the middle line, with the sharpest of knives. The structures shown in fig. 320 should then be recognised. The skin is seen to become continuous with the mucous membrane at the outer margin of the lip. Beneath the skin is the subcutaneous tissue containing, in the male, the beard-roots ; in the sub-mucous tissue is seen a close series of labial glands, rounded minute bodies, which secrete moistening fluid for the lips in health and give rise to thin labial crusts (sordæ) in disease. The central basis of the lip is muscle; the upper fibres, under the mucous membrane and margins, seen in cross-section, belong to the encircling fibres of the *orbicularis oris*, while the lower vertical fibres are those of the *depressor labii inferioris*. Rising below the incisor teeth and ending in the skin over the chin are seen the fibres of the *levator menti* (figs. 320, 322). The *coronary artery*, which may be felt by the tongue beating on the inner surface of the lip, opposite the incisor crowns, is seen in section under the mucous membrane. Lower down, branches of the inferior labial artery may be seen. The upper lip presents a similar arrangement of structures on section (fig. 320).

The section made in the lower lip is now to be sewn up, and, at the same time, the anterior margins of the upper and lower lips stitched together, to give a firm basis for the dissection of their muscles. The eyelids should also be stitched together now.

A vertical incision in the middle line should be made from the forehead along the roof of the nose to the chin, and the skin reflected outwards to the ear. The student is probably already familiar with the *naso-labial fold and furrow*, so often pronounced features of the face. The furrow slants downwards and outwards from the nose to beyond the angle of the mouth and separates the upper lip from the cheek. He will find that the skin, which is so tightly bound to the upper lip, becomes free beyond this furrow and can be dissected off with ease. On the alæ and tip of the nose, and on the free part of the lower lip, he will also find the skin tightly bound down and almost impossible of reflection without injuring the underlying structures. The subcutaneous tissue of the face is, as a rule, comparatively free from fat, highly vascular, with an active reparative power. One side of the face should be reserved for dissection of muscles, the other for working out the nerves and vessels.

FIG. 320.—SECTION OF THE LIPS. (*Semi-diagrammatic.*)



Muscles which act on the Lips and Mouth.—The *facial* (VII) is the motor nerve of all the face muscles (muscles of expression), and in the dissection of each muscle the facial branch which supplies it should be looked for.

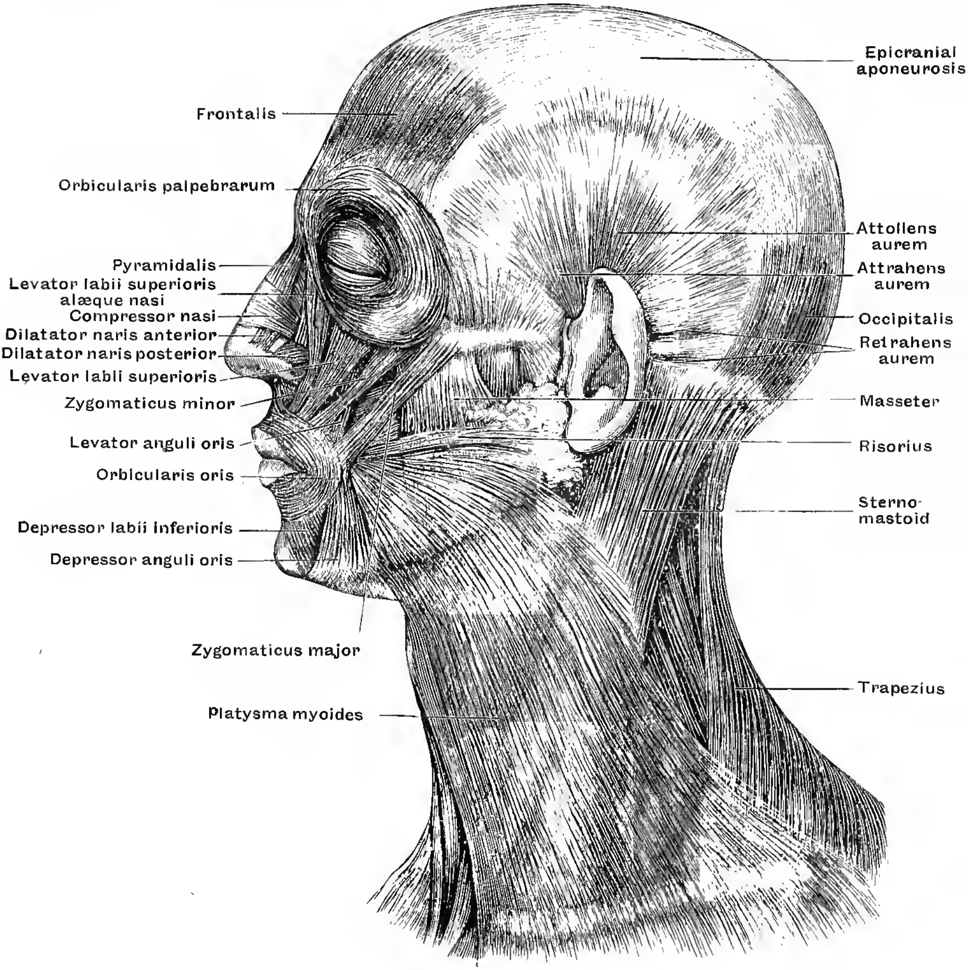


FIG. 321.—THE SUPERFICIAL MUSCLES OF THE HEAD AND NECK. (*From Morris's 'Anatomy.'*)

(1) PLATYSMA. Although the greater part of the platysma ends on the oblique line of the lower jaw, yet many of its superficial and posterior fibres end in the skin and muscles near the angle of the mouth (fig. 321). The student may

verify on himself the power which this muscle has, not only to raise the skin on the side of the neck, but also to retract and depress the angle of the mouth. He may also observe that he instinctively tightens it in effort and anger. Below the chin is a decussation of the mesial fibres of the two sides.

(2) The DEPRESSOR ANGULI ORIS (fig. 321) has a wide origin from the oblique line of the lower jaw, and a narrow insertion at the angle of the mouth (Plate LII). Some of its fibres mix, and are in continuity with the levator anguli oris (fig. 322). Together the depressor and levator compress the mouth and individually may elevate or depress its angle.

(3) The DEPRESSOR LABII INFERIORIS rises from the anterior part of the oblique line and outer part of the mental eminence, lying beneath the last muscle at its origin. It ends in the skin and muscle of the lower lip.

(4) The LEVATOR MENTI elevates and corrugates the skin over the chin (fig. 322). It rises from the jaw below the lateral incisor tooth (Plate LII, p. 180). It assists in raising the lower lip so as to get rid of the food which tends to collect between the teeth and lip.

(5) The RISORIUS (fig. 321) is an irregular and variable slip of muscle rising in the pre-auricular subcutaneous tissue and passing to the angle of the mouth.

(6) The ZYGOMATICUS MAJOR (fig. 321) passes to the angle of the mouth and dense tissue of the upper lip from the zygomatic process of the malar. When it acts, the upper lip is pulled upwards and outwards and passes under the cheek by deepening the naso-labial fold, as may be observed best in crying babies.

(7) The ZYGOMATICUS MINOR (fig. 321) passes from the malar bone, internal to the major muscle, and ends in the upper lip. It assists the larger muscle.

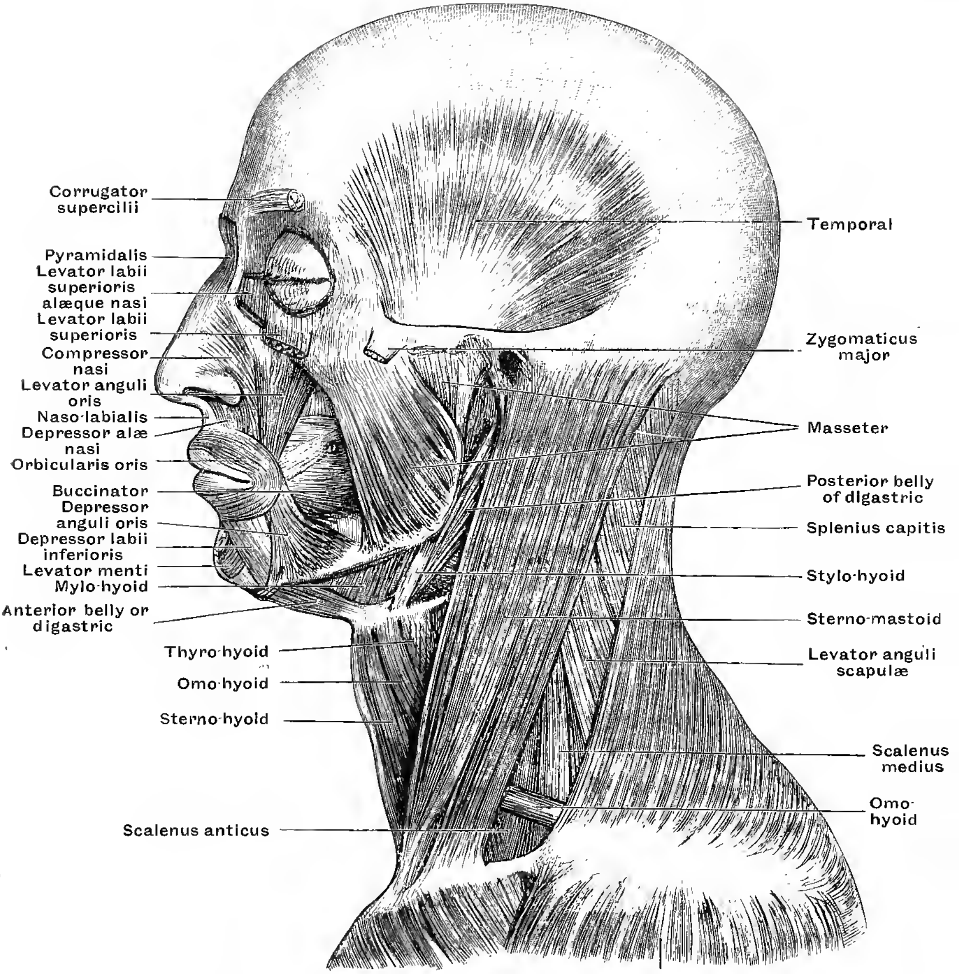
(8) The LEVATOR LABII SUPERIORIS rises from the lower margin of the orbit, under the orbicularis palpebrarum (Plate L, p. 130) and ends in the substance of the upper lip, below the naso-labial fold. Sometimes the outer orbicular fibres of the eyelids are continued into it.

(9) The LEVATOR LABII SUPERIORIS ALÆQUE NASI (fig. 321) rises from the inner margin of the orbit and ends in the upper lip and tissue round the ala of the nose, below the naso-labial fold.

These nine muscles just dissected should now be cut completely away.

(10) The Levator Anguli Oris (musculus caninus) is situated in a deeper plane, beneath that of the levator labii

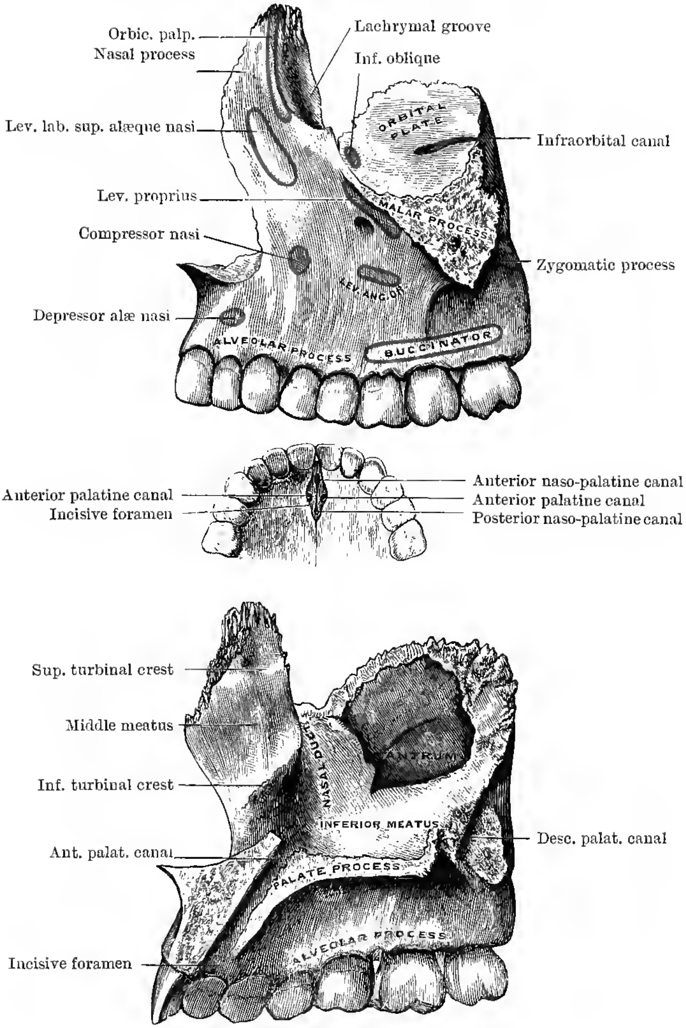
Fig. 322.—The deeper layer of the muscles of the face and neck. (*From Morris's 'Anatomy.'*)



superioris (fig. 322). It arises from the superior maxillary bone, below the infra-orbital foramen and escaping infra-orbital artery and nerve (Plate L). It ends in the fibro-muscular

PLATE L

THE OUTER AND INNER ASPECTS OF THE SUPERIOR MAXILLARY BONE. (*H. E. Clark.*)



tissue at the angle of the mouth. It lifts the upper lip and exposes the canine tooth.

(11) BUCCINATOR (fig. 322). The origin of this muscle from the pterygo-maxillary ligament and from the outer aspect of the molar alveoli of the upper and lower jaws is at present hid by the masseter muscle, and will have to be verified later (fig. 367, p. 193). The fibres pass forwards to the lips and form a large part of the orbicularis oris. The fibres from the outer aspect of the alveolus of the upper jaw pass mostly to the lower lip, and those from the lower jaw to the upper lip. The student will observe the facial vessels passing upwards over it, and the duct of the parotid crossing the masseter to perforate the muscle (fig. 355, p. 174). On it lies the long buccal, a sensory nerve ending in the skin and mucous membrane of the cheek. The buccinator is the muscle of the cheek, and its characteristic action can be studied when whistling and during mastication, when it keeps the food within the teeth. It helps to compress the lips and mouth. A rounded pad of fat (the sucking pad) lies on it in very young children.

(12) The SUPERIOR INCISIVE MUSCLE (fig. 323, 10) arises from the alveolus of the upper jaw, above the lateral incisor tooth, and radiates outwards into the fibres of the orbicularis oris and tissue of the upper lip. It is best seen by everting the upper lip, after the stitches have been undone from the mouth, and dissecting off the mucous membrane as it is reflected from the lip to the gum. It puckers and everts the lip.

(13) The NASO-LABIAL MUSCLE (fig. 323, 9) arises from the upper jaw at the lower margin of the pyriform aperture and nasal spine. It passes into the tissue of the upper lip and joins the orbicularis oris.

(14) The INFERIOR INCISIVE MUSCLE in the lower lip resembles the corresponding muscle in the upper lip and may be exposed in a similar manner.

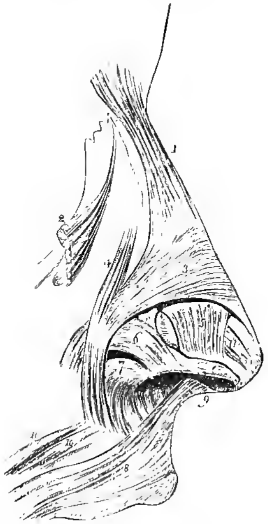
(15) The ORBICULARIS ORIS (fig. 322) acts as a sphincter to the mouth. It is composed of fibres derived from the buccinator, naso-labial, superior and inferior incisive muscles.

The complicated labial movements required in speech and in the numerous shades of expression are produced by adjusting the actions of all these muscles.

Muscles and Cartilages of the Nose.—Over the alar cartilages, which form the bases of the alæ and tip of the nose, the skin is intimately adherent and contains numerous sebaceous glands. It is this part of the nose which is liable to certain diseases, such as lupus, and, in certain constitutions and conditions, to exaggerations of the natural complexion. The muscles of the nose are not well marked.

(1) The Pyramidalis Nasi is a continuation of the mesial fibres of the frontalis muscle (fig. 323, 1). It ends in an aponeurotic expansion over the roof of the nose. When in action it produces a transverse puckering of the skin at the root of the nose.

Fig. 323.—Muscles of the nose. (*Wilson.*)



1. Pyramidalis nasi. 2. Upper part of the levator labii superioris alæque nasi turned aside. 3. Compressor nasi. 4. Musculus anomalus. 5, 6. Dilator alæ nasi. 7. Part of the depressor alæ nasi. 8. Upper segment of the orbicularis oris. 9. Naso-labialis. 10. Upper incisive muscle.

(2) The Compressor Nasi (fig. 323, 3) arises from the superior maxilla, internal to the origin of the levator anguli oris, and spreads, as it passes inwards, to end on aponeurotic tissue over the roof of the nose (Plate L). When in action the skin on the side of the nose is thrown into folds, as in expressions of contempt.

(3) The Dilator Alæ Nasi (fig. 323, 5, 6) is a flat short band which arises from the lateral margin of the pyriform aperture, and passes downwards and inwards to end in the ala of the nose. It is a respiratory muscle which lifts the ala upwards and outwards in forced inspiration.

(4) The Depressor Alæ Nasi (fig. 323, 7) arises in continuity with the naso-labial muscle, of which it is part, and ends in the ala of the nose.

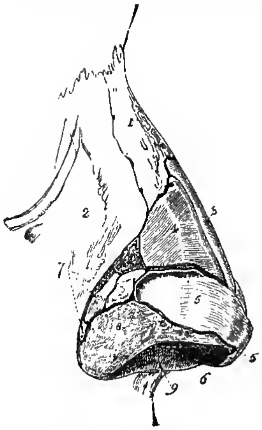
The **Cartilages of the Nose** (figs. 324, 325) should be examined now, for if left until the nasal cavity is examined they will be found dried and unfit for dissection.

The Alar Cartilages, one on each side, form the basis of the alæ and tip of the nose (figs. 324, 325). At the tip of the nose they bend inwards and their septal limbs form a part of the nasal septum (the columna, fig. 325, 5). The shape of the nasal tip depends largely on the extent to which the septal limbs are pressed together.

The LATERAL CARTILAGES (fig. 324, 4) are continuous with the septal cartilage along their mesial margins. They fill the interval on the roof of the nose between the alar cartilages below and the margin of the pyriform aperture above.

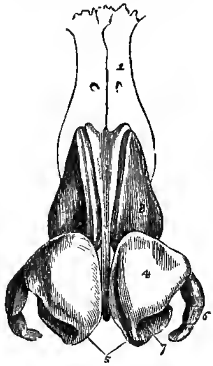
The SESAMOID CARTILAGES (fig. 324, 7) are isolated pieces imbedded in the membrane which fills a hiatus between the alar, lateral cartilages, and margin of the pyriform aperture.

FIG. 324.—THE CARTILAGES AND BONES OF THE NOSE VIEWED FROM THE SIDE. (*Arnold.*)



1. Nasal bone. 2. Nasal process of the superior maxillary bone. 3. Cartilage of the septum. 4. Lateral cartilage. 5, 5. Alar cartilage. 6. Inner portion of the alar cartilage. 7. Sesamoid cartilages. 8. Areolar tissue of the ala nasi. 9. Aperture of the nostril.

FIG. 325.—THE CARTILAGES OF THE NOSE VIEWED FROM THE FRONT. (*Wilson.*)



1. One of the nasal bones. 2. Cartilage of the septum. 3. Lateral cartilage. 4. Alar cartilage. 5. Central portions of the alar cartilages which constitute the columna. 6. Sesamoid cartilages. 7. The nostril.

Muscles surrounding the Orbit.—The ORBICULARIS PALPEBRARUM surrounds the orbit, covers the eyelid and acts as a sphincter to the palpebral fissure (fig. 321, p. 128). The *orbital* or outer fibres form a series of loops with their origin and insertion closely set together on the *internal tarsal ligament*, or *tendo oculi* (fig. 321, p. 128), and the ascending nasal process of the maxilla, at the inner margin of the orbit (see Plate L, p. 130). Below, the fibres overlap the origin of the levator labii superioris; above the orbit the terminal fibres of the frontalis and corrugator supercilii mix with them (figs. 321 and 322). At the outer margin of the orbit, contraction of the orbicularis causes the familiar crow's-foot wrinkles in the skin. The *palpebral* or inner fibres rise from the upper and lower margins of the internal tarsal ligament, and pass outwards in the upper and lower lids to be inserted to the outer tarsal ligament (fig. 321). On the margins of the lids the fibres are collected into a rounded bundle (ciliary bundle). The palpebral fibres close the eye, the movement being one which almost entirely affects the upper lid alone. The *levator palpebræ superioris*, its opponent, lies within the orbit. Although the nerve supply comes from the facial, its nerve fibres appear to arise, in part at least, from the oculo-motor and not from the facial nucleus. In a corresponding manner the nerve fibres for the orbicularis oris probably arise from the hypoglossal nucleus. Painful diseases of the cornea cause the orbicularis palpebrarum to pass into a condition of spasm. The orbicularis palpebrarum is also one of the most useful muscles of expression.

The **Facial Nerve (VIIth)** (fig. 326, 17) is the motor nerve of the scattered subcutaneous sheet of muscle found on the face, head, and neck. From its origin in the floor of the fourth ventricle to its final distribution, four distinct stages in its course are recognised.

(*a*) Within the skull and internal auditory meatus (Plate LIII, p. 244).

(*b*) Its passage through the temporal bone by the aqueductus Fallopii (see fig. 413, p. 268).

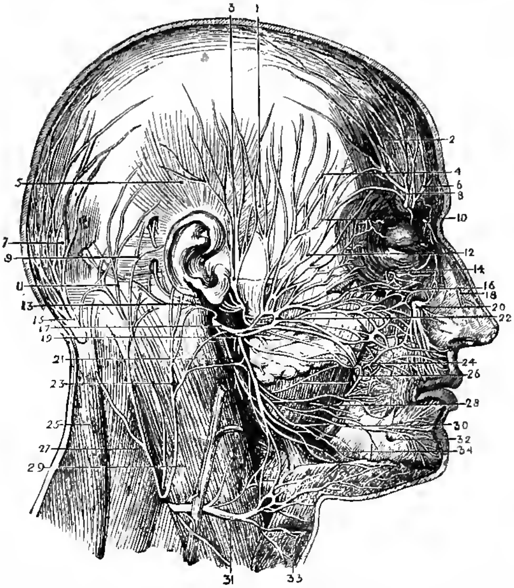
(*c*) A stage within the parotid gland where it divides (fig. 326, 17).

(*d*) The distribution of its final branches in the subcutaneous tissue (fig. 326).

Only the latter two stages can be examined now.

If the student will refer to the dried skull he will find the stylo-mastoid foramen, at which the facial nerve escapes, in line with the anterior border of the mastoid process and at a depth of about one inch from its outer surface. It is at this point he should now look for the facial nerve, an operation he may have reason to repeat in actual practice (fig. 311, p. 107). To expose the nerve an incision should be made along the anterior border of the mastoid process and continued downwards for one and a half inches on the anterior border of the sterno-mastoid muscle. Using the handle of his knife with some vigour, he should push forwards the parotid gland and expose the posterior belly of the digastric muscle proceeding forwards from beneath the mastoid process. In the angle between the anterior border of the mastoid process and this muscle the facial nerve should be seen, passing forwards in the parotid gland. Here he should look for three of its branches:

Fig. 326.—Nerves of the face and scalp (*Hirschfeld and Leveillé.*)



1. Attrahens auriculam muscle. 2. Anterior belly of occipito-frontalis. 3. Auriculo-temporal nerve. 4. Temporal branches of facial nerve. 5. Attollens auriculam muscle. 6. Supra-trochlear nerve. 7. Posterior belly of occipito-frontalis. 8. Supra-orbital nerve. 9. Retrahens auriculam muscle. 10. Temporal branch of orbital nerve (superior maxillary). 11. Occipitalis minor nerve. 12. Malar branches of facial. 13. Posterior auricular. 14. Malar branch of temporo-malar. 15. Great occipital. 16. Infra-orbital branches of facial. 17. Facial. 18. Nasal branch of ophthalmic. 19. Cervico-facial division of facial. 20. Infra-orbital branch of fifth. 21. Branches of facial to digastric and stylo-hyoid. 22. Temporo-facial division of facial. 23. Great auricular. 24. Buccal branches of facial. 25. Trapezius muscle. 26. Long buccal. 27. Small occipital. 28. Buccal branches. 29. Sterno-mastoid. 30. Mandibular branches. 31. Superficial cervical. 32. Mental. 33. Sterno-hyoid. 34. Cervical branches.

(1) The Posterior Auricular, passing upwards behind and beneath the ear to supply the occipitalis and auricular muscles (fig. 311, p. 107).

(2) A branch to the posterior belly of the digastric (fig. 326, 21).

(3) A branch to the stylo-hyoid.

As the nerve is followed into the parotid, superficial to the temporo-maxillary vein and external carotid artery, it is found to break up into a series of branches (*pes anserinus*) which escape from the anterior and lower borders of the gland (fig. 326).

Of these the student should seek the following:

(1) The CERVICAL BRANCHES to the platysma, behind the angle of the jaw (fig. 326, 34).

(2) The MANDIBULAR to the muscles of the lower lip (fig. 326, 30).

(3) The BUCCAL branches to the buccinator and muscles at the angle of the mouth (fig. 326, 28).

These three commonly arise together from the lower division of the facial nerve—the *cervico-facial* division (fig. 326, 19). The following three arise from the upper division—the *temporo-facial* (fig. 326, 22):

(4) The INFRA-ORBITAL, to the muscles ending in the upper lip.

(5) The MALAR, over the malar bone to the orbicularis palpebrarum.

(6) The TEMPORAL branches stream upwards over the zygoma and supply the attrahens auriculam and muscles on the forehead.

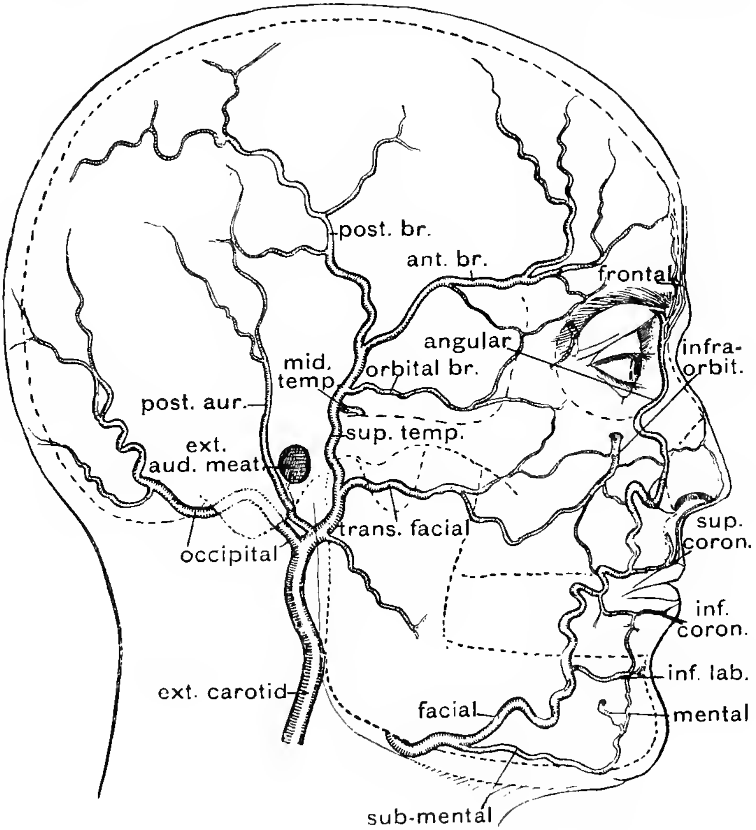
All these terminal branches communicate with the sensory nerves of the face and neck, but the meaning of the communications has yet to be explained (see fig. 326).

The **Facial Artery** (fig. 327) can be felt pulsating as it crosses the lower jaw in front of the insertion of the masseter. At this point it can be readily pressed, for it is covered only by skin, subcutaneous tissue and platysma. The student should seek for it at this point as it escapes from the sub-maxillary triangle, between the lower border of the jaw and sub-maxillary gland. The facial vein at this point lies close behind it, and the sub-maxillary lymphatic glands, into which the lymph vessels of the face drain, lie on each side of it. Its origin from the external carotid and its course in the carotid triangle have been described (fig. 291, p. 61).

The artery passes obliquely across the cheek, under the insertions of the platysma and zygomatici. In this part of its course, as it lies on the buccinator, it is tortuous, to permit movements of the cheek and lower jaw. It courses up by the side of the nose and terminates at the inner canthus of the eye as the angular artery (fig. 327). The angular artery ends by anastomosing with the nasal branch of the ophthalmic artery. There is a free anastomosis between all the arteries which end on the face.

The following branches, besides numerous twigs to the structures of the cheek, are to be looked for:

FIG. 327.—THE COURSE AND BRANCHES OF THE FACIAL ARTERY. (*F. W. Jones.*)



(1) The INFERIOR LABIAL to the tissues of the lower lip. It anastomoses with the mental and submental arteries (fig. 327).

(2) The INFERIOR CORONARY unites with the artery of the opposite side in the sub-mucous tissue of the lip (see fig. 320, p. 127).

(3) The SUPERIOR CORONARY (fig. 327) occupies a corre-

sponding situation in the upper lip. The exact position of this artery should be observed, as it has to be compressed in operations for hare-lip. It gives off a branch (*artery of the septum*) to the floor and septum of the nose.

(4) The LATERAL NASAL ARTERY ends on the side and roof of the nose.

The **Facial Vein** (see fig. 307, p. 102) does not correspond to the artery either in course or distribution. It begins as the angular vein which is formed at the inner canthus of the eye by the union of the frontal and supra-orbital veins. At its origin from the angular vein it is in free communication with the superior and inferior ophthalmic veins, and through them with the cavernous sinus. Its course down the face lies along the anterior border of the masseter, some distance behind that of the artery. It crosses the termination of the parotid (Stenson's) duct as it rests on the buccinator and receives from beneath the masseter the *deep facial* vein from the pterygoid plexus (fig. 307, p. 102). Branches corresponding to those of the artery join it. On the jaw it is in contact with and behind the artery. While the artery lies deep to the submaxillary gland, the vein passes down superficial to it and joins the anterior division of the temporo-maxillary; the temporo-facial trunk thus formed ends in the internal jugular.

Minor Arteries of the Face.

(1) The TRANSVERSE FACIAL ARTERY, a branch of the superficial temporal, crosses the masseter muscle above the parotid duct and ends in the tissues of the cheek (fig. 327). It anastomoses with branches of the facial and infra-orbital arteries, and is sometimes of considerable size, replacing in part the distribution of the facial.

(2) The NASAL BRANCH of the ophthalmic appears on the face above the internal tarsal ligament and joins the angular.

(3) The termination of the INFRA-ORBITAL ARTERY is to be found at the infra-orbital foramen (fig. 327).

(4) The MENTAL BRANCH of the inferior dental artery escapes at the mental foramen, below the lower bicuspid teeth (fig. 327).

Sensory Nerves of the Face.

(1) The INFRA-ORBITAL NERVE (fig. 326, 20) will be found under the origin of the levator labii superioris, half an inch below the inferior orbital margin, and somewhat to the nasal

side of the middle point of that margin. It supplies the skin of the cheek from the margin of the lower eyelid to the margin of the upper lip.

(2) The MALAR BRANCHES (fig. 326, 14) from the second division of the fifth should be looked for as they escape by two or more canals in the malar bone. They supply the prominent part of the cheek, an area often highly coloured in life.

(3) The INFRA-TROCHLEAR BRANCH (see fig. 326) of the nasal nerve will be found as it passes over the internal tarsal ligament to end on the skin of the root of the nose and lachrymal sac.

(4) The NASAL NERVE (fig. 326, 18), from the ophthalmic division of the fifth, appears between the nasal bone and lateral nasal cartilage and ends in the skin of the roof and tip of the nose. It has four distinct stages after it leaves the orbit and before it becomes superficial on the nose:

(*a*) In the anterior ethmoidal canal;
(*b*) On the cribriform plate within the skull;
(*c*) Between the ethmoid and frontal;
(*d*) On the under surface of the nasal bone, which it grooves.

(5) The LONG BUCCAL (fig. 326, 26), a branch of the third division of the fifth, appears in the fat beneath the masseter and passes forwards on the buccinator towards the angle of the mouth. It supplies the mucous membrane on the inner side and the skin on the outer side of the cheek.

(6) The MENTAL NERVE (fig. 326, 32), from the third division of the fifth, will be found as it escapes at the mental foramen, below the two lower bicuspid teeth. It is a branch of the inferior dental, and supplies the lower lip and skin over the chin.

(7) The GREAT AURICULAR (fig. 326, 23), from the second and third cervical nerves (p. 74), sends a facial branch to supply the skin over the parotid and angle of the jaw.

In practice it is found that the area of anæsthesia which follows section of a sensory nerve is very much less than the area of distribution. Section of the infra-orbital nerve, for instance, produces only a small patch of anæsthesia on the cheek. The smallness of the anæsthetic area is commonly supposed to be due to an overlapping in the distribution of contiguous nerves.

Lymphatics of the Face. (See fig. 307, p. 102.)—The lymphatics from the greater part of the face follow the course of the facial vein and end in the group of glands (SUB-MAXILLARY) round the facial artery and on the lower margin of the jaw and surface of the sub-maxillary gland. The student will probably have observed that these glands enlarge with any sore situated about the cheek, nose, or mouth. They receive lymphatics from the gums, lower lip, tongue, forehead, nose and inner part of eye, and have to be extirpated in any operation undertaken for the radical cure of cancer of these parts.

Some lymphatics from the lower lip end in a SUB-MENTAL GLAND, situated above the body of the hyoid bone (fig. 307, p. 102).

The lymph vessels from the temples and outer side of the orbit and eyelids pass to the PAROTID SET OF GLANDS in front of the ear (fig. 307, p. 102).

Antrum of Highmore (Sinus Maxillaris).—It is important that a cursory examination of the antrum of Highmore of one side should be made at this stage of dissection, because it is from the facial aspect of the upper jaw that the surgeon has to approach this cavity. The soft structures having been cleared away from the anterior surface of the bone, an opening should be made large enough to admit the thumb below and to the outer side of the infra-orbital foramen, with either a chisel or trephine. The cavity will be found lined by mucous membrane. The canal for the infra-orbital nerve can be seen running backwards on the roof (fig. 346, p. 163); the opening into the middle meatus can be distinguished on the anterior part of the inner or nasal wall. Elevations along its floor, caused by the roots of the molar and biscupid teeth, will explain to the student how it is that pus may appear in the antrum from disease of the teeth, and how the cavity could be drained by tapping it through a tooth socket. It will be readily perceived, too, how tumours growing within the antrum may push up its roof and protrude the eyeball or fungate through on the face. He will also see how it is possible to follow the infra-orbital nerve along the roof and, using it as a guide, thus reach the spheno-palatine ganglion in the spheno-maxillary fossa through the posterior wall of the antrum (see fig. 413, p. 268).

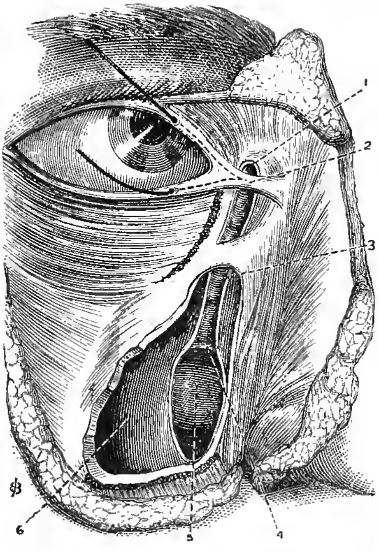
DISSECTION X

THE ORBIT AND ITS CONTENTS

The **Eyelids.**—It is better to put off the dissection of the parotid, temporal, and pterygoid regions for the present, and turn for a day to the dissection of the orbit and all that pertains to it, while the parts are still moist and easy of dissection. As far as possible, the student should seek to build up his conception of the eyeball and the structures which surround it in the orbit as viewed from the front, for it is from this aspect that he has to deal with it in practice. Three fibrous structures, closely connected with the eyelids, should be examined first, viz. the internal tarsal ligament, the palpebral membrane, and the tarsal plates.

Fig. 328.—The lachrymal apparatus and nasal duct. (*Bellamy.*)

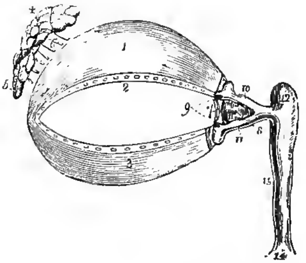
(Bristles are introduced into the puncta lachrymalia.)



1. Lachrymal sac. 2. Tendo oculi or internal tarsal ligament. 3. Valvular folds in nasal duct. 4. Orifice of nasal duct. 5. Lower turbinated bone. 6. Inner wall of antrum.

The **Internal Tarsal Ligament** or **Tendo Oculi** passes from the inner ends of the eyelids across the lachrymal sac, to which it is the surgical guide, and becomes attached to the ascending nasal process of the superior maxilla in front of the lachrymal groove (fig. 328). It can always be made taut and prominent by drawing the eyelids outwards. Only the skin and superficial fascia have to be reflected to expose it. To keep it stretched the external canthus of the eye should be fixed outwards by a hook. The attachment of the orbicularis palpebrarum to it should be dissected away. The infra-trochlear nerve and the nasal branch of the ophthalmic artery should be looked for as they escape in the fatty, fibrous tissue above it (fig. 304, p. 97). The angular artery passes over or near it, to anastomose with the nasal artery. Behind its inner half, filling the lachrymal groove, will be found the thick fibrous wall of the lachrymal sac, which may be opened by a vertical cut, made above and below the ligament (fig. 328). Externally the ligament divides into an upper and lower process, which end in the tarsal plates of the upper and lower lids. The ligament keeps the eyelids in position and gives origin to part of the orbicularis palpebrarum (fig. 328).

FIG. 329.—APPENDAGES OF THE EYE. (*Wilson.*)



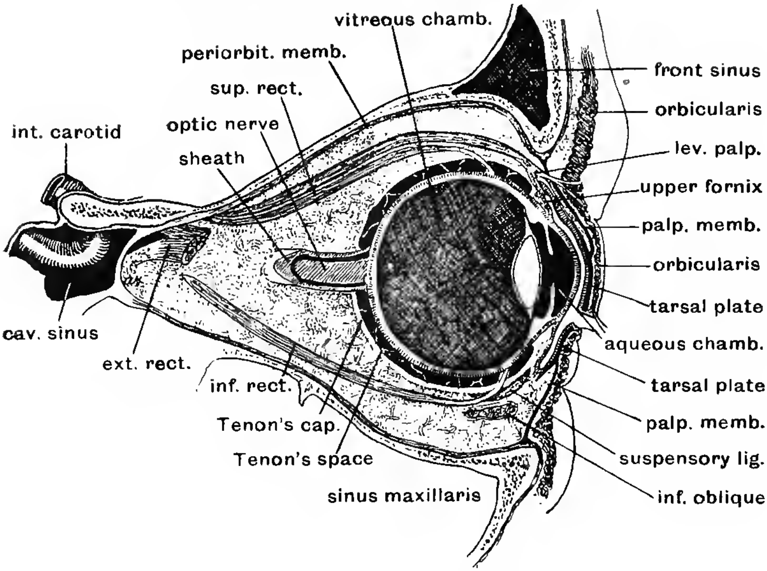
1. Superior tarsal plate. 2. Lower border of the plate on which are seen the openings of the Meibomian glands. 3. Inferior tarsal plate; along the upper border of this plate the openings of the Meibomian glands are likewise seen. 4. Lachrymal gland, its superior or orbital portion. 5. Inferior or palpebral portion. 6. Lachrymal ducts. 7. Plica semilunaris. 8. Caruncula lachrymalis. 9. Puncta lachrymalia. 10. Superior lachrymal canaliculus. 11. Inferior lachrymal canaliculus. 12. Lachrymal sac. 14. Dilatation of the nasal duct, where it opens into the inferior meatus of the nose. 15. Nasal duct.

The **Palpebral** (orbital) **Membrane** or **Fascia** is exposed when the orbicularis palpebrarum is reflected. It closes the orbit in front and offers resistance to the escape of blood or pus from that cavity. At its circumference it is continuous with the periosteum at the margin of the orbit, except at the trochlea, where there is a distinct hiatus by which the supratrochlear nerve escapes. The membrane converges from the circumference of the orbit to become attached to the anterior aspects of the tarsal plates in the upper and lower eyelids (fig. 330). At the inner extremity of the eyelids it becomes thickened and forms the *internal tarsal ligament,* while a less distinct thickening, which joins the eyelids to the outer margin of the orbit, is distinguished as the *external tarsal ligament.*

The **Tarsal Plates** (fig. 329, 1, 3) form the firm basis of the eyelids, and are composed of dense fibrous tissue. Over their free margins are imbedded the roots of the eyelashes, and in them lie the Meibomian glands (fig. 331, 8). They are bound at their outer and inner ends to the margin of the orbit by the tarsal ligaments. The orbital membrane is united to them, not at their free margin, but on their anterior aspects (fig. 330).

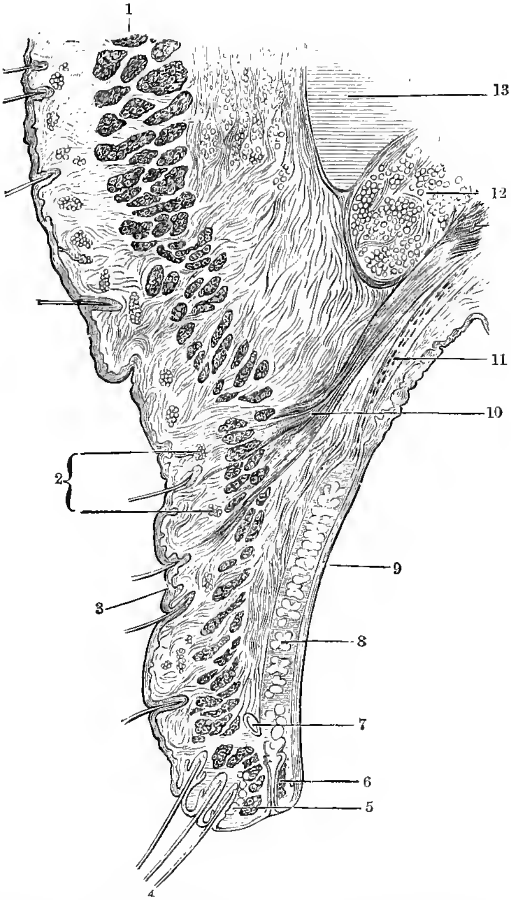
Section of the Upper Eyelid (see fig. 331).—A vertical section should be made through both upper and lower eyelids in the line of the pupil. The parts to be looked for are shown in figure 331. On the outer surface is seen the skin, with a thin, loose subcutaneous tissue, free of fat. It contains the roots of fine hairs. The palpebral membrane appears in section with the orbicularis superficial to it (fig. 330). Part of the insertion of the levator palpebræ is seen to perforate the membrane, and gain an attachment to the anterior surface of the tarsal plate. The conjunctiva commences at the anterior edge of the free margin of the lids, and lines their ocular surface; then it is reflected on the eyeball (fig. 330). The angle formed by the reflection is the *fornix*. Foreign bodies in the eye are more difficult to extract from the upper than from the lower fornix, because of its greater depth. In the sub-conjunctival tissue of the lids there is normally a slight amount of lymphoid tissue, which in diseased conditions may increase and give rise to granular lids.

Fig. 330.—Section of the orbit and eye to show Tenon's capsule and space, and the chambers of the eye. (*Diagrammatic.*)



The Meibomian Follicles (fig. 331, 8) are imbedded in the tarsal plates, and can be seen on the conjunctival surface as parallel lines of minute yellowish beads (fig. 332, 1). They end on the free margin of the lids, near the inner edge. Their secretion moistens and lubricates the opposed edges of the eyelids, but in diseased conditions it becomes viscid and causes the lids to stick.

FIG. 331.—SECTION OF UPPER EYELID. (*After Merkel.*)



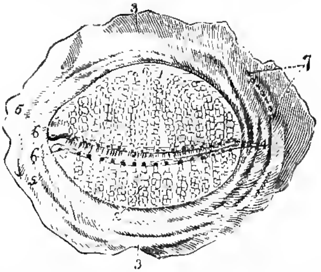
1. Orbicularis palpebrarum. 2. Sudoriparous glands. 3. Skin. 4. Eyelashes. 5. Sebaceous glands of eyelash. 6. Ciliary muscle of Riolan. 7. Vein. 8. Meibomian glands. 9. Conjunctiva palpebræ. 10. Levator palpebræ. Fibres lost in the integument. 11. Levator palpebræ. 12. Orbital fat. 13. Margin of orbit.

The EYELASHES are best developed in the upper lid, where they form rather an irregular double row. Their sheaths are imbedded in the subcutaneous tissue over the free margins of the tarsal plates (fig. 331, 4). Inflammation of the root of an eyelash gives rise to a 'stye'; inflammation of their sheaths or in the lids leads to contorted growth of the eyelashes. Bundles of the palpebral part of the orbicularis pass among their roots, and may lead to the cilia assuming abnormal positions (fig. 331).

The LEVATOR PALPEBRÆ SUPERIORIS will be seen afterwards running forwards beneath the roof of the orbit, but its insertion in the eyelid is best seen now (fig. 330). It is the opponent of the orbicularis palpebrarum and raises the upper eyelid. Its deeper fibres are inserted to and raise the upper fornix of the conjunctiva; its anterior part blends with the palpebral membrane, and is attached to the orbicularis and anterior surface of the tarsal plate. It is also connected with the upper edge of the tarsal plate by a layer of involuntary muscular fibres.

PALPEBRAL ARTERIES (see fig. 338, p. 154).—The nasal artery gives off at the inner angle of the eye an upper and lower palpebral branch, which course outwards on the eyelids to anastomose with corresponding branches given off by the lachrymal at the outer angle.

FIG. 332.—MEIBOMIAN GLANDS, AS SEEN UPON THE INNER ASPECT OF THE EYELIDS. (*Arnold.*)



1. Upper lid. 2. Lower lid. 3, 3. Conjunctiva. 4. Apertures of the Meibomian glands, forming a row along the free border of each eyelid. 5, 5. Papillæ lachrymales. 6, 6. Puncta lachrymalia. 7. Apertures of the efferent ducts of the lachrymal gland.

The following SENSORY NERVES end in the eyelids (fig. 304, p. 97):—(1) Palpebral branches of the infra-trochlear nerve at their inner ends; (2) branches of the infra-orbital in the lower lid; (3) branches of the lachrymal in the outer segment of the upper lid; (4) minute branches of the supra-orbital and supra-trochlear in the middle of the upper lid.

Lachrymal System. This comprises:—

(1) Lachrymal Gland.
(2) Lachrymal Papillæ and Puncta.
(3) Lachrymal Canals or Canaliculi.
(4) Lachrymal Sac.
(5) Nasal Duct.
(6) The eyelids also form an essential part of the apparatus.

By their movements the tears are forced from the eye into the achrymal sac.

The **Lachrymal Gland** (figs. 329, p. 142, and 335, 4, p. 150), by which tears are secreted, is situated above and to the outer side of the eyeball, within the upper and outer angle of the orbit. The palpebral membrane should be detached from the margin of this angle of the orbit and turned down; the anterior edge of the gland then comes into view. It is by this route that the surgeon gains access to the gland. In the normal condition of parts it is not possible to distinguish the gland clearly with the finger in life, although it is only covered by skin, subcutaneous tissue, orbicularis and palpebral membrane. When the loose tissue in the angle is picked away with the forceps, the two parts of the gland—*orbital* and *palpebral*—can be made out. If the student pushes the handle of his knife into the fornix of the conjunctiva, beneath the outer half of the upper lid, the *palpebral* part will be seen, resting on the conjunctiva, and composed of ten to twelve semi-detached nodules, each opening by its own duct at the fornix. The orbital part is flat, oval and compact, and its ducts open at the outer end of the fornix. This part is compressed against the frontal and malar bones in the outer angle of the orbit. The outer edge of the levator palpebræ cuts into the gland, between the orbital and palpebral parts. The lachrymal artery and nerve will be better seen afterwards, when the roof of the orbit is removed. Its capsule is made up of the lax orbital tissue which surrounds the gland.

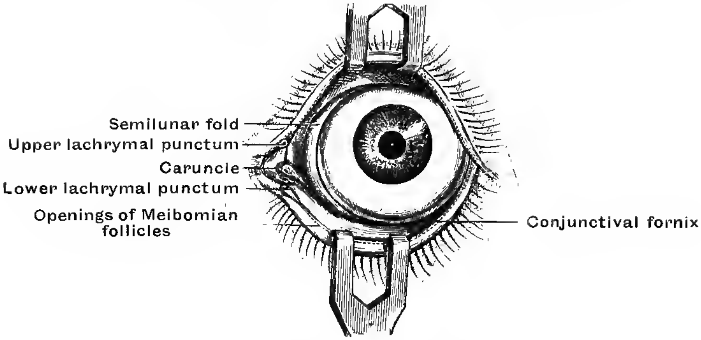
HOW THE TEARS ARE CONVEYED TO THE NASAL CAVITY (fig. 328, p. 141).—The secretion of the lachrymal gland passes across the eye, moistening the cornea and eyelids, to be collected at the inner canthus or angle by the *upper and lower lachrymal canals* and by them conducted to the lachrymal sac. The lachrymal sac communicates with the inferior meatus of the nose by the *nasal duct*.

Lachrymal Canals.—Near the inner end of each eyelid, and on the free margin, there will be seen a conical papilla (papilla lachrymalis) with a small opening on the apex (punctum lachrymale) at which the upper and lower lachrymal canals commence (fig. 329, 9). As the lids open and shut the apices of the papillæ, which are turned inwards, rub in the vertical grooves which lie at each side of the *plica semilunaris* (fig. 333).

The cicatrisation which follows inflammation of the lids may turn the papillæ outwards, with the result that the normal lachrymal secretion, being no longer caught at the puncta, overflows and trickles down the cheek. The lachrymal canals, which are imbedded in the firm fibrous tissue behind the internal tarsal ligament (fig. 328), surround the *caruncula lachrymalis* and unite together as they enter the outer side of the lachrymal sac (fig. 329). The student should lay these canals open, a procedure which the surgeon has occasionally to undertake. He will see that they bend suddenly inwards at the base of the papillæ (fig. 329).

The CARUNCULA LACHRYMALIS (fig. 333) contains a few hair roots; the plica semilunaris, between it and the eye, represents the third eyelid of the cat and membrana nictitans of birds.

FIG. 333.—VIEW OF EYEBALL &C. OBTAINED ON DRAWING THE LIDS FORCIBLY APART. (*After Merkel, from Morris's 'Anatomy.'*)

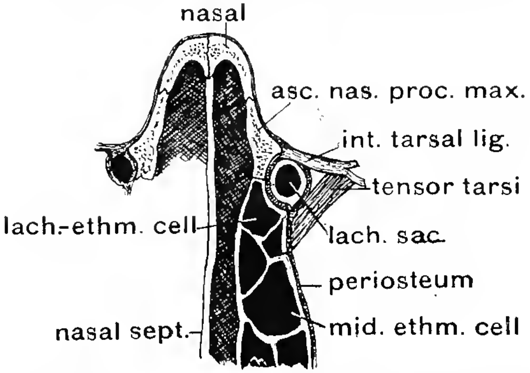


The **Lachrymal Sac** (fig. 328, p. 141) fills the lachrymal groove, formed by the lachrymal bone and ascending nasal process of the superior maxilla, and lies behind the inner half of the internal tarsal ligament, to which it is firmly adherent. The sac should be laid open by a vertical incision in front, the internal tarsal ligament being cut at the same time. Its wall, which is continuous with the periosteum of the lachrymal fossa, is thick and resistant (fig. 334).

The **Nasal Duct** (fig. 328, p. 141) will be found, when a probe is passed into it from the lachrymal sac, to pass downwards and slightly outwards and backwards, and to be of slightly less calibre than the sac. It is about 15 mm. long and will take a probe with a diameter of 3 mm. ($\frac{1}{8}$ inch). The lachrymal passage from the eye to the nose is lined by ciliated epithelium. The mucous membrane in the upper part of the nasal duct is thrown into slight folds; it has a thick submucous coat, in which constrictions may form after inflammatory conditions. Strictures may occur at any point. The nasal duct perforates the mucous membrane of the inferior meatus (as will be seen later) in the same oblique valvular manner as the ureter enters the bladder. Were it not so, the lachrymal apparatus would become inflated every time the nose is blown.

The TENSOR TARSI muscle (fig. 334) lies on the same plane and behind the internal tarsal ligament and lachrymal sac. To see it, snip through the eyelids near their inner extremities with scissors and throw them with the internal tarsal ligament inwards. The fibres of the tensor tarsi will then be seen rising behind the lachrymal sac from the lachrymal crest and passing outwards to end in the inner extremities of the upper and lower tarsal plates. When the muscle contracts it pulls the eyelids inwards so as to press and adjust their edges when the eye is closed. It may also compress and empty the sac to some extent. It is supplied from the facial nerve.

FIG. 334.—SECTION OF THE LACHRYMAL SAC TO SHOW ITS RELATIONSHIP TO THE INTERNAL TARSAL LIGAMENT AND TENSOR TARSI.



The ORIGIN OF THE INFERIOR OBLIQUE, from the floor of the orbit, will be seen when the attachment of the palpebral membrane to the lower margin of the orbit is cleared away (Plate L, p. 130). The muscle can be followed backwards and outwards until it perforates a horizontal plane of fibrous tissue passing from the outer to the inner wall of the orbit under the eyeball. This *suspensory ligament* (Lockwood) is part of the capsule of Tenon, and keeps the eyeball from falling downwards when, for some diseased condition, the upper jaw has been removed.

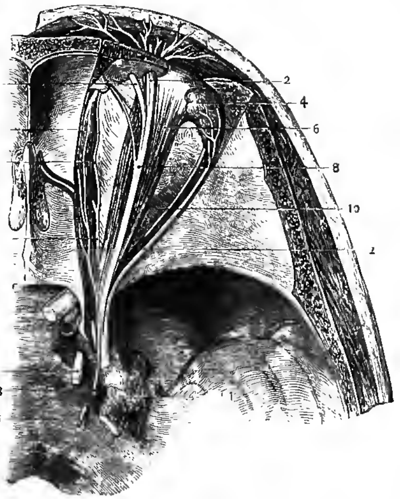
The **Capsule of Tenon** (see fig. 330, p. 143) is the synovial bursa in which the eyeball rests and rotates, and through which the ocular muscles must pass to gain insertion to the eyeball. About 8 mm. ($\frac{1}{3}$ of an inch) behind the margin of the cornea and within the capsule of Tenon will be found the tendinous insertions of the ocular muscles. The capsule will be better seen when the roof of the orbit is removed, but it is important to examine it from the front, as it is by cutting through the ocular reflection of the conjunctiva and then opening the capsule that the surgeon reaches the insertions of the ocular muscles in cases of squint. The student should expose the insertion of the external rectus in the following manner:—Fix the eyelids as far apart as possible; snip through the conjunctiva with scissors at its reflection on the outer side of the eye. The fibrous tissue beneath it, adherent to both the conjunctiva and sclerotic coat of the eyeball, is the anterior part of the capsule of Tenon. When it is cut through the student will find he has gained entrance to the space within the capsule and will be able to see the tendon of the external rectus perforating it to reach the eyeball. He will see further that when the tendon is divided the muscle is still fixed in the wall of the capsule and through it may still act on the conjunctiva and eyeball (fig. 330, p. 143). The insertions of the other muscles can be reached in precisely the same manner. He must not expect the inner surface of the capsule to be perfectly smooth; he will find everywhere fine fibres joining it to the sclerotic coat of the eyeball. Further, he will observe that the capsule of Tenon is bound to the outer wall of the orbit by the strong *external check ligament,* to the inner wall by the slighter *internal check ligament,* and to the roof by a fibrous prolongation round the tendon of the superior oblique. By these fibrous bands, the eyeball is retained in place within the orbit.

Dissection of the Orbit from the Roof.—The calvarium must be removed again, the head propped forward so as to bring the base of the skull nearly into the horizontal position, and the roof of the orbit removed with saw and chisel, after the manner shown in fig. 335. The section of bone removed is composed of the orbital plate of the frontal, with a part of the small wing of the sphenoid. It is very thin, and may easily be perforated by a foreign body thrust into the orbit against it.

The student should at this stage examine the orbital cavity of a skull, especially the sphenoidal fissure and optic foramen, by which openings structures pass between the cranial and orbital cavities (see Plate LI, p. 152). He will notice in his dissection that the dura mater and cavernous sinus completely occlude the sphenoidal fissure (fig. 330, p. 143).

The **Periorbital Membrane** (fig. 330) is seen when the roof is removed. It is the periosteum of the orbital walls; behind it becomes continuous with the dura mater at the sphenoidal fissure, especially with the part forming the cavernous sinus; in front it becomes continuous with the periosteal covering of the bones surrounding the orbit and also with the circumference of the palpebral membrane.

Fig. 335.—Superficial dissection of the nerves of the orbit. (*Hirschfeld and Leveillé.*)



1. Supra-trochlear nerve. 2. Supra-orbital nerve. 3. Obliquus superior. 4. Lachrymal gland. 5. Infra-trochlear nerve. 6. Levator palpebræ superioris. 7. Nasal nerve (fifth). 8. Frontal nerve (fifth). 9. Optic nerve. 10. Rectus superior. 11. Third nerve. 12. Lachrymal nerve. 13. Fourth nerve. 14. Gasserian ganglion of fifth. 15. Sixth nerve.

When the exposed part of the periorbital membrane is cut away the following structures are seen :

(1) The Fourth Cranial Nerve (fig. 335, 13) passing along the upper surface of the superior oblique and supplying that muscle. It reaches the sphenoidal fissure in the outer wall of the cavernous sinus, and passes into the orbit beneath the small wing of the sphenoid (fig. 336).

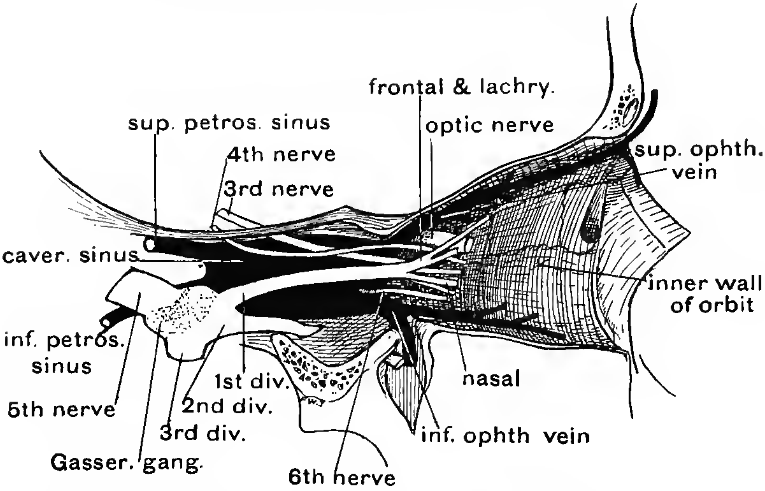
(2) The Frontal Nerve (fig. 335, 8), which passes forwards above the levator palpebræ superioris, and, before it escapes from

the orbit, divides into *supra-orbital* and *supra-trochlear* nerves (p. 98). It is a branch of the ophthalmic division of the fifth, which reaches the sphenoidal fissure in the outer wall of the cavernous sinus (fig. 336).

(3) The SUPRA-ORBITAL ARTERY, a branch of the ophthalmic, joins the frontal nerve over the levator palpebræ superioris and accompanies the corresponding nerve to the forehead.

(4) The LACHRYMAL NERVE (fig. 335, 12). It supplies the lachrymal gland with secretory and sensory fibres, and ends in the skin over the upper and outer angle of the orbit. Like the frontal nerve, it is derived from the ophthalmic division of the fifth. In its passage forwards, above the external rectus, it gives off a branch which joins with one from the superior maxillary on the outer wall of the orbit. The malar and temporal nerves arise from the *temporo-malar* loop thus formed.

FIG. 336.—DIAGRAM OF THE OPHTHALMIC VEINS, CAVERNOUS SINUS, AND THE NERVES IN THE WALL OF THE SINUS. (*F. W. Jones.*)



(5) The LEVATOR PALPEBRÆ SUPERIORIS takes its origin above the optic foramen (Plate LI, p. 152) and, expanding as it passes forwards, ends in the upper eyelid and conjunctiva, as already described (fig. 330). From its lateral margins, fibrous expansions pass to the orbital surfaces of the outer and inner angular processes.

(6) The RECTUS SUPERIOR is seen when the last muscle is

detached at its origin and reflected forwards. If the bone roofing over the optic foramen is chipped away, the muscle will be found to arise from the upper part of a *fibrous collar* encircling the entrance of the optic nerve and continuous with the periosteum round the optic foramen. The muscle passes forwards and, perforating the capsule of Tenon, is inserted to the sclerotic coat of the eye. When it contracts, the cornea is turned upwards and slightly inwards.

(7) The OBLIQUUS SUPERIOR (fig. 335, 3) arises from the fibrous collar internal to the origin of the rectus superior (see Plate LI, p. 152). Lying along the inner wall of the orbit, and under the roof, it ends in a tendon which hooks round the trochlea, a fibrous loop attached to the trochlear impression of the orbital roof (fig. 343, p. 160). It is inserted on the posterior and outer aspect of the sclerotic, passing under the rectus superior. When it contracts, the pupil is turned downwards and outwards, thus correcting the tendency of the rectus superior and inferior to turn the pupil inwards. A small bursa surrounds the tendon at the trochlea. The capsule of Tenon sends a prolongation to the trochlea round the tendon of the superior oblique.

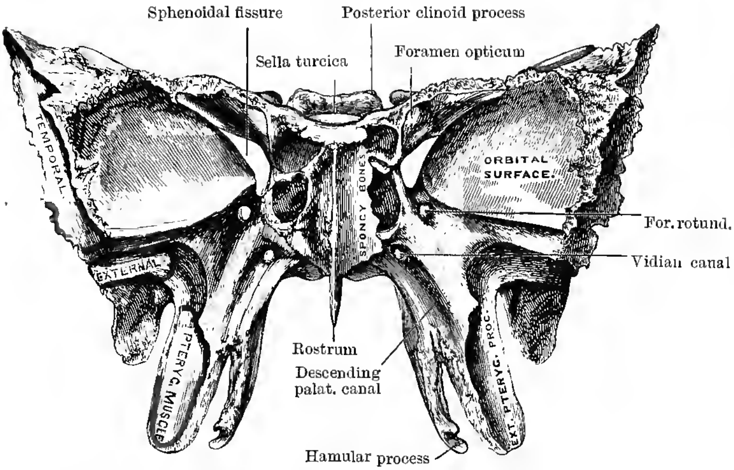
The seven structures just described, with the exception of the levator palpebræ, should be cut through in front and reflected backwards. The trochlea and tendon of the superior oblique and terminal part of the rectus should be left *in situ*.

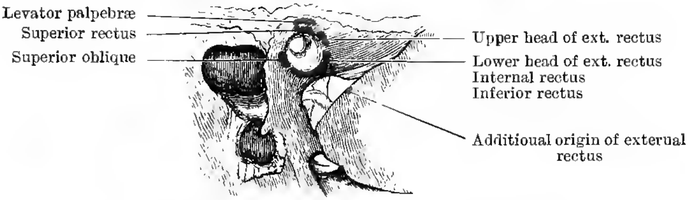
The ORBITAL part of the lachrymal gland can now be more fully examined (see p. 146 and fig. 335, 4). The lachrymal nerve has just been described; beneath it will be found the LACHRYMAL ARTERY (fig. 338, K), a branch of the ophthalmic. It supplies the gland and ends in the outer parts of the eyelids and neighbouring structures. A *meningeal* branch of the artery enters the cranium in the outer part of the sphenoidal fissure, and is sometimes of considerable size. It communicates with the middle meningeal. The orbital part of the gland fills a fossa within the upper and outer angle of the orbit; it rests on the levator palpebræ superioris, capsule of Tenon, and external rectus.

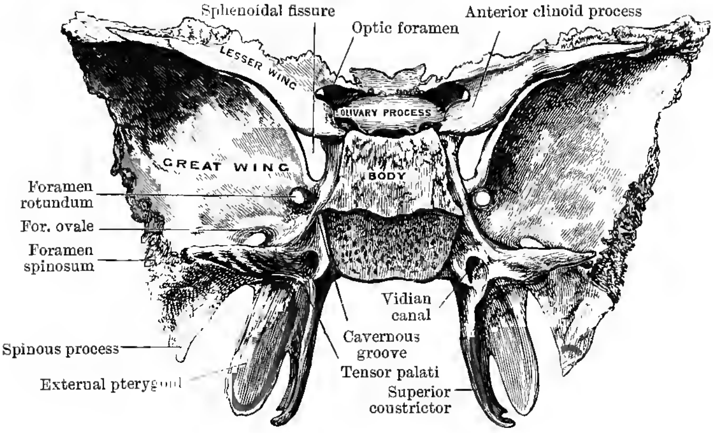
The **Capsule of Tenon** should now be investigated. It is apparent to the dissector, and is well shown in vertical section (fig. 330, p. 143), that the structures within the orbit are packed in a matrix of connective tissue, which, in a state

PLATE LI

TWO ASPECTS OF THE SPHENOID WITH THE MUSCULAR ATTACHMENTS TO EACH. (*H. E. Clark.*)

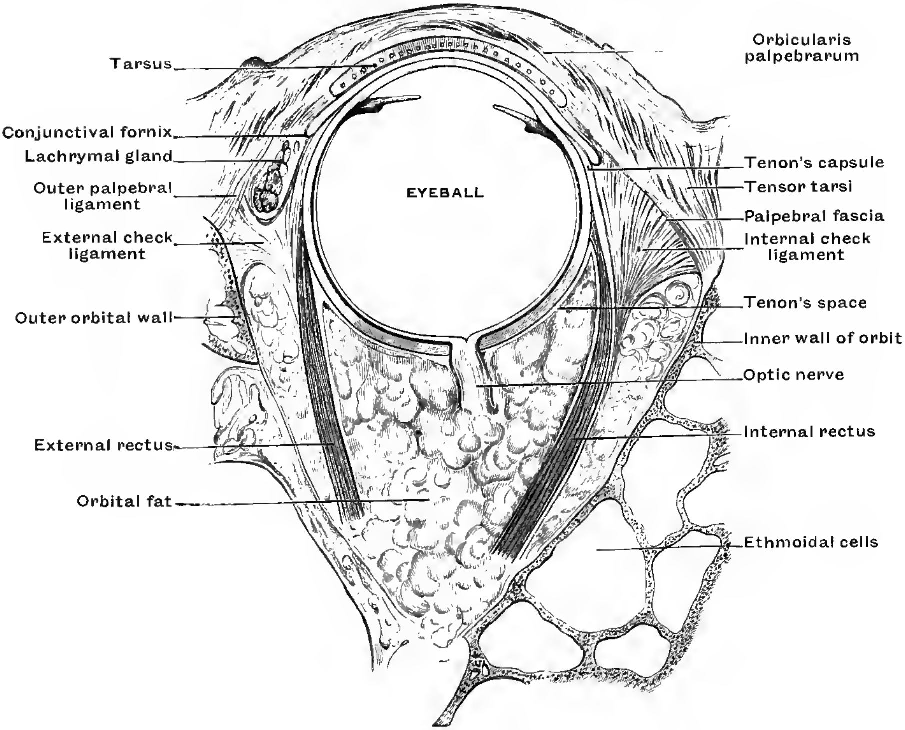



Levator palpebræ
Superior rectus
Superior oblique
Upper head of ext. rectus
Lower head of ext. rectus
Internal rectus
Inferior rectus
Additional origin of external rectus



of health, contains a considerable amount of fat. In wasting diseases the fat is absorbed, and the eyeball appears sunken within its socket. It will be seen how easily inflammatory processes may spread in it and work complete destruction of the contents of the orbit. The connective tissue of the orbit which immediately surrounds the sclerotic part of the eyeball, from the entrance of the optic nerve behind to the reflection of the conjunctiva in front, is condensed into a fibrous bursal cup, in which the eyeball freely rotates. This is the CAPSULE OF TENON. The lymph space between the capsule and the sclerotic is TENON'S SPACE. The following features of the capsule should now be examined (see fig. 330, p. 143, and fig. 337):—

FIG. 337.—HORIZONTAL SECTION THROUGH LEFT ORBIT, VIEWED FROM ABOVE. (*After Von Gerlach, from Morris's 'Anatomy.'*)



(1) Cut through the capsule, some distance behind the insertion of the superior rectus, to the eyeball, and see that the

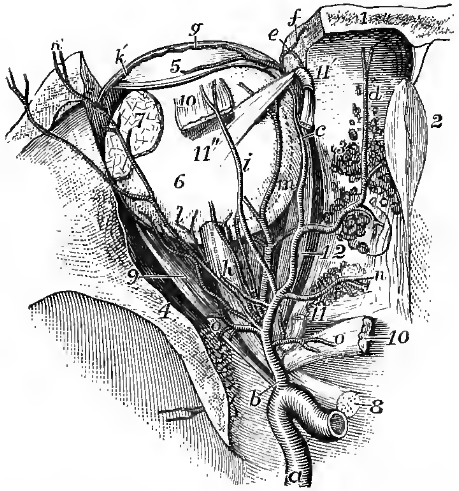
great lymph space which separates it from the eyeball is crossed by numerous white fibres.

(2) Its outer surface is continuous with the surrounding tissue of the orbit.

(3) It is attached to the optic nerve behind, and to the conjunctiva in front.

(4) It is perforated by, and forms sheaths for, all the ocular muscles as they pass to their insertions on the sclerotic.

Fig. 338.—Distribution of the ophthalmic artery. (*Merkel and Henle.*)



1. Frontal bone. 2. Crista galli. 3. Cribriform plate. 4. Lesser wing of sphenoid. 5. Upper eyelid. 6. Eyeball. 7. Lachrymal gland. 8. Optic nerve. 9. External rectus muscle. 10, 10. Cut ends of superior rectus. 11. Origin of superior oblique. 11.' Pulley for its tendon. 11.'' Insertion of tendon. 12. Internal rectus. *a.* Internal carotid artery. *b.* Ophthalmic. *c.* Terminal branch dividing into (*e*) Nasal and (*f*) Frontal. *d.* Anterior ethmoidal. *g.* Palpebral. *h.* Central artery of retina *i.* Supraorbital. *k.* Lachrymal. *k'.* Palpebral branch of lachrymal. *l.* Short ciliary. *m.* Long ciliary. *n.* Posterior ethmoidal.

(5) That at the perforation of the external and internal recti it sends fibrous prolongations to the outer and inner walls of the orbit, which limit the extent to which these muscles may contract (*external* and *internal check ligaments*) (fig. 337).

(6) Its prolongation to the trochlea should be followed.

(7) Its suspensory part, which has been already mentioned (p. 149). It passes from the inner to the outer wall of the orbit, and acts as a hammock for the eyeball. It is pierced by the inferior oblique. Enucleation of the eyeball is performed by detaching it within the capsule of Tenon ; the muscles, the optic nerve, ciliary arteries and nerves are cut as they cross Tenon's space to the eyeball (fig. 330).

The **Ophthalmic Artery** (fig. 316, p. 118) springs from the internal carotid, and at once passes through the optic foramen, at first below, and then to the outer side of the optic nerve. When within the orbit, it crosses obliquely above the optic nerve from without inwards, and ends at the inner angle of the orbit by dividing into the nasal and frontal arteries (fig. 338). The nasal communicates with the angular artery—the terminal twig of the facial. The artery may be divided into *three stages*: (1) on the outer side of the optic nerve; (2) over the optic nerve; (3) on the inner side of the optic nerve and along the inner wall of the orbit.

The branches of the ophthalmic artery may be divided into the following three sets; the individual branches of each set being examined:—

A. **For the Eyeball.**—They arise from the first and second stages.

(*a*) Central Artery of the Retina (fig. 338, H).—This perforates the outer side of the optic nerve in front of the optic foramen, and passes forwards in the nerve. It appears within the eyeball at the optic disc, and supplies the retina (fig. 348, p. 167). Embolism of this artery causes blindness.

(*b*) Short Ciliary Arteries (fig. 338, L).—These run along both sides of the optic nerve, pierce the sclerotic, and end as shown in fig. 351, 19, p. 170.

(*c*) Long Ciliary Arteries (fig. 338, M).—These, commonly two in number, run forwards to perforate the sclerotic anteriorly, and supply the conjunctiva, cornea, ciliary, bodies and iris (fig. 351, 13, 15, p. 170). Anterior Ciliary Twigs are supplied from the muscular branches of the ophthalmic artery (fig. 351, 7).

B. **For Orbital Structures.**

(*a*) Lachrymal Artery
(*b*) Supra-orbital Artery
(*c*) Outer Muscular Arteries
(*d*) Inner Muscular Arteries

Arise before the ophthalmic artery crosses the optic nerve. The first two of these branches have been already examined; the last two are now to be sought for.

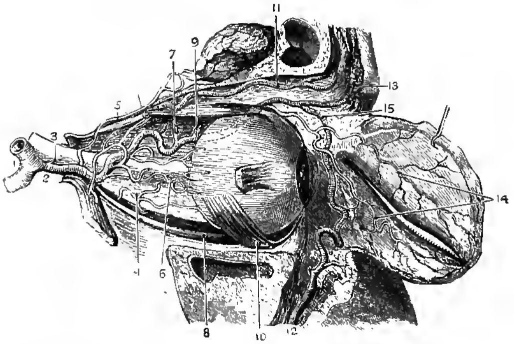
C. **Branches ending outside the Orbit.**—They arise from the third stage.

(*a*) Posterior Ethmoidal (fig. 338, N).—This artery passes by the posterior ethmoidal canal to the cribriform plate, within the skull. It gives branches to the meninges and lining membrane of the ethmoidal sinuses.

(*b*) Anterior Ethmoidal Artery (fig. 338, d).—This branch accompanies the nasal nerve through the anterior ethmoidal canal, across the cribriform plate, and enters the roof of the nasal cavity between the frontal and ethmoid; it ends in the mucous membrane of the nasal cavity. It supplies branches to the meninges as it crosses the cribriform plate, to the lining membrane of the anterior ethmoidal cells and frontal sinus.

(*c*) The Palpebral Branches (fig. 339, 14) arise at the inner angle of the eye, supply the conjunctiva, lachrymal sac, and pass outwards in the eyelids. They end by anastomosing with the palpebral branches of the lachrymal (fig. 338, k′).

Fig. 339.—Arteries of the orbit from the outer side.
(*From Hirschfeld and Leveillé.*)



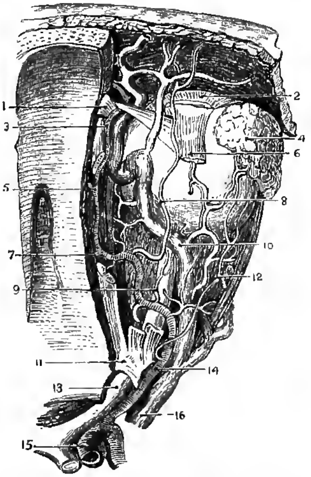
1. Internal carotid. 2. Ophthalmic artery. 3. Arteria centralis retinæ. 4. Muscular branches. 5. Lachrymal artery. 6. Ciliary artery. 7. Posterior ethmoidal artery. 8. Rectus inferior. 9. Anterior ethmoidal artery. 10. Obliquus inferior. 11. Supra-orbital artery. 12. Facial artery. 13. Frontal artery. 14. Palpebral arteries. 15. Nasal artery.

(*d*) The Frontal Artery (fig. 339, 13) arises from the terminal stage of the ophthalmic, near the inner wall of the orbit. It accompanies the supra-trochlear nerve, and ends in the tissue of the forehead and scalp.

(*e*) The Nasal Artery, one of the terminal branches, crosses the internal tarsal ligament and lachrymal sac and ends by anastomosing with the angular artery (fig. 327, p. 137).

The Ophthalmic Veins differ somewhat from the artery in course and distribution. There are two of them, a *superior* (fig. 340, 10), draining the eyeball and the structures in the upper part of the orbit, and ending between the heads of the external rectus in the cavernous sinus; and an *inferior*, draining the structures in the floor of the orbit, communicating with the great venous plexus round the external pterygoid muscle, through the spheno-maxillary fissure, and ending in the cavernous sinus with the superior between the heads of origin of the external rectus (fig. 336, p. 151). The communications of the ophthalmic veins are particularly worthy of consideration, as through them infective processes may spread from the face or zygomatic fossa to the cavernous sinus and cause thrombosis of the veins and sinus. The frontal and supra-orbital veins communicate with the superior ophthalmic vein, but end chiefly in the facial (fig. 340).

Fig. 340.—Arteries and veins of the orbit. (*From Hirschfeld and Leveillé.*)



1. Pulley of superior oblique tendon. 2. Levator palpebræ (cut). 3. Trunk of ophthalmic artery from which the frontal, nasal, and palpebral branches are derived. 4. Lachrymal gland. 5. Anterior ethmoidal artery. 6. Rectus superior (cut). 7. Posterior ethmoidal artery. 8. Supra-orbital artery. 9. Ciliary arteries. 10. Ophthalmic vein. 11. Origins of obliquus superior, levator palpebræ, and superior rectus. 12. Lachrymal artery. 13. Optic nerve. 14. Ophthalmic artery. 15. Carotid artery. 16. Caveruous sinus.

Veins of the Eyeball.—The blood poured into the eyeball by the ciliary arteries is conveyed away by four or five *venæ vorticosæ* (fig. 341). These perforate the sclerotic near the equator of the eyeball, and join the ophthalmic veins. The central vein of the retina accompanies the central artery, and ends in the superior opthalmic vein.

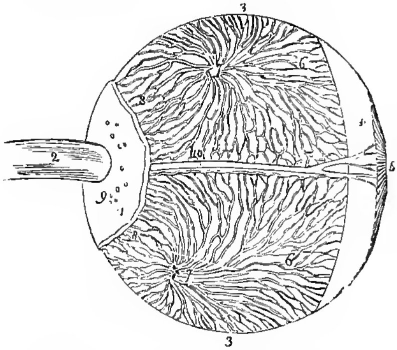
The **Nerve Supply of the Eye** should now be examined.

(1) The Short Ciliary Nerves (fig. 342, 15), about six in number, will be found passing forwards in the connective tissue round the optic nerve, and perforating the sclerotic near the entrance of that nerve. They proceed forwards beneath the sclerotic, as will be seen in the dissection of the eye, and supply motor fibres to the ciliary or focusing muscle and to the

muscular fibres of the iris, which constrict and dilate the pupil, besides sensory fibres to the eyeball.

(2) The LENTICULAR or CILIARY GANGLION (fig. 342, 7) will be found between the optic nerve and external rectus by tracing backwards the short ciliary nerves, which arise from it. The ganglion is not easily found, as it is little larger than the head of a pin. The ophthalmic artery, before crossing the optic nerve, passes over the ganglion. By picking it up in his forceps and pulling it somewhat forwards, the student will find it is connected behind by the following roots (fig. 342A) ;

FIG. 341.—DISSECTION OF THE EYEBALL, SHOWING ITS SECOND TUNIC, AND THE MODE OF ORIGIN OF THE VENÆ VORTICOSÆ OF THE CHOROID. (*Arnold.*)



1. Part of the sclerotic coat. 2. Optic nerve. 3, 3. Choroid coat. 4. Ciliary ligament. 5. Iris. 6, 6. Venæ vorticosæ. 7, 7. Trunks of the venæ vorticosæ at the point where they have pierced the sclerotic. 8, 8. Posterior ciliary veins, which enter the eyeball in company with the posterior ciliary arteries, by piercing the sclerotic at 9. 10. One of the long ciliary nerves, accompanied by a long ciliary vein.

(*a*) A *long root* from the nasal branch of the fifth, through which it receives sensory fibres for the eye.

(*b*) A *short root*, from the branch of the third nerve to the inferior oblique, through which it receives motor fibres for the ciliary muscle and constrictor fibres of the iris (fig. 342, 8).

(*c*) A sympathetic root from the cavernous plexus on the internal carotid, thereby receiving vasomotor and irido-dilator fibres from the first cervical ganglion (fig. 413, p. 268). Thus it is that excision of the first cervical ganglion leads to constriction of the pupil and a sinking inwards of the eyeball.

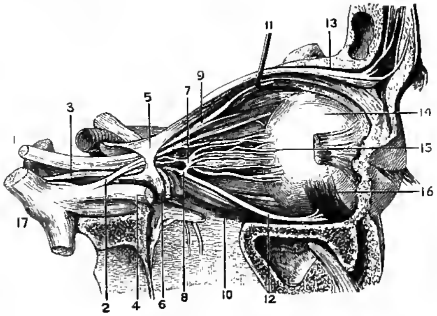
(3) TWO LONG CILIARY NERVES pass directly from the nasal nerve, along with the short nerves, to the eyeball (see fig. 342). The cornea is supplied with sensation by those nerves; they pass forwards in the eyeball, as will be seen later, within the firm, unyielding sclerotic coat. Hence in glaucoma, when the intra-ocular tension is greatly raised, these nerves are compressed, the cornea becoming partially anæsthetic.

Motor Nerves of the Orbit.—(1) The FOURTH CRANIAL

Nerve has already been seen to end in the Superior Oblique (fig. 335, p. 150).

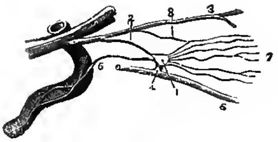
(2) The Third Cranial Nerve (fig. 336, p. 151) passes from the outer wall of the cavernous sinus to the orbit, through the sphenoidal fissure, between the two heads of origin of the external rectus (fig. 342, 1). It divides into an *upper division*, which supplies the levator palpebræ and rectus superior, and a *lower*, which ends in the rectus internus, rectus inferior, and obliquus inferior (fig. 342, 9, 12). Between its two divisions the nasal nerve will be seen to pass forwards.

Fig. 342.—Nerves of the orbit, seen from the outer side. (*From Hirschfeld and Leveillé.*)



1. Third Nerve. 2. Nasal nerve, giving off a long ciliary nerve in the orbit, and the long root of the lenticular ganglion before entering the orbit. 3. Sixth nerve. 4. Trunk of ophthalmic nerve (5th). 5. Ligament of Zinn. 6. Origin of external rectus. 7. Lenticular ganglion (the long root is joining it behind). 8. Short root of lenticular ganglion. 9. Branch of third nerve to levator palpebræ superioris and superior rectus. 10. Inferior rectus. 11. Hook placed on superior rectus. 12. Branch of third nerve to obliquus inferior. 13. Frontal nerve (cut). 14. Eyeball. 15. Short ciliary nerve. 16. Inferior oblique. 17. Gasserian ganglion.

Fig. 342a.—Diagram of the lenticular ganglion. (*From Hirschfeld and Leveillé.*)



1. Lenticular ganglion. 2. Long root from—3. Nasal branch of fifth. 4. Short root from—5. Nerve to inferior oblique. 6. Sympathetic root from cavernous plexus. 7. Short ciliary nerves. 8. Long ciliary nerves.

(3) The Sixth Cranial Nerve passes from the cavernous sinus to within the orbit, and ends in the rectus externus. It passes through the sphenoidal fissure between the two heads of the external rectus, being the lowest in position of all the nerves in the sphenoidal fissure (fig. 342, 3).

Sensory Nerves of the Orbit.—(1) The Frontal and Lachrymal have been seen passing forwards beneath the roof of the orbit (fig. 335, p. 150). They enter by the sphenoidal fissure above the origin of the external rectus.

(2) The Nasal Nerve leaves the ophthalmic division of the

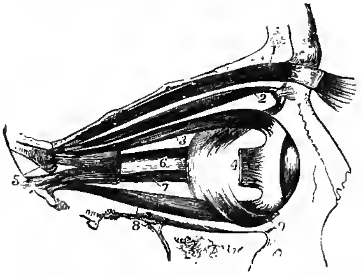
fifth in the outer wall of the cavernous sinus, and enters the orbit between the two heads of the rectus externus (fig. 342, 2). It passes forwards between the two divisions of the third nerve, crosses the optic nerve to reach the anterior ethmoidal foramen on the inner wall of the orbit, from which point its course has already been traced (p. 139). The following branches are to be sought for :

(*a*) *Long Root* of the ciliary ganglion.

(*b*) *Long Ciliary Nerves.*

(*c*) *Infra-trochlear Branch.*—This springs from the nasal at the inner wall of the orbit, passes forwards between the trochlea and internal tarsal ligament. It supplies the lachrymal sac and structures at the inner side of the eye, and ends in the skin over the root of the nose (fig. 304, p. 97).

FIG. 343.—MUSCLES OF THE EYEBALL. THE VIEW IS TAKEN FROM THE OUTER SIDE OF THE RIGHT ORBIT. (*Wilson.*)



1. Levator palpebræ superioris. 2. Obliquus superior. 3. Rectus superior. 4. Insertion of rectus externus. 5. Double origin of rectus externus. 6. Optic nerve. 7. Rectus internus. 8. Rectus inferior. 9. Obliquus inferior.

The **Optic Nerve** runs forwards and slightly outwards to perforate the sclerotic 3 mm. internal to the antero-posterior axis of the eye. The relationship of the ophthalmic artery, nasal nerve, lenticular ganglion, ciliary nerves, and third nerve to the optic nerve should be noted and these structures then cut away (see figs. 339 and 342). Cut the optic nerve through as it appears in the orbit surrounded by the fibrous collar which gives origin to the ocular muscles. When examined in section the optic nerve will be seen to be surrounded by a stout sheath derived from the dura mater, while between the sheath and nerve a distinct space will be observed, which is lymphatic in nature and offers a highroad for the spread of septic processes from the eyeball to the sub-arachnoid cavity of the brain (fig. 330, p. 143). The dural sheath fuses at the eyeball with the sclerotic. The optic fibres perforate the sclerotic by numerous foramina (area cribrosa) and spread out at the optic disc, as will be seen presently, to form the innermost layer of the retina.

Ocular Muscles.—Six muscles arise within the orbit and end on the eyeball; through these the eyes are directed towards the object under examination. They are (see fig. 343):—

(1) Superior rectus; turns the pupil upwards and slightly inwards.

(2) Inferior rectus; turns the pupil downwards and slightly inwards.

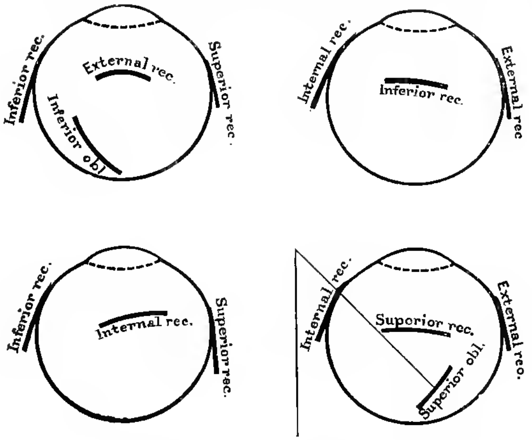
(3) External rectus; turns the pupil outwards.

(4) Internal rectus; turns the pupil inwards.

(5) Superior oblique; turns the pupil downwards and outwards.

(6) Inferior oblique; turns the pupil upwards and outwards.

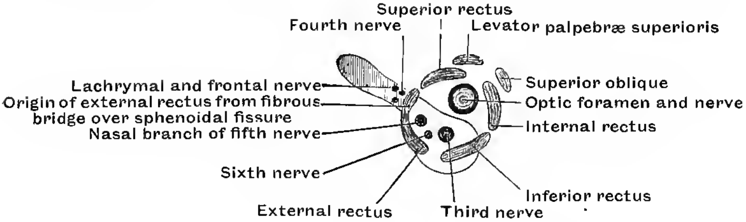
Fig. 344.—Diagrammatic view of the insertions of the ocular muscles. (*After Merkel.*)



Insertion of the Muscles to the Eye.—All six muscles, as they terminate, pass through the capsule of Tenon and have therefore still a loose connection with the eyeball after their insertions are cut (see fig. 330, p. 143). Through the outer and inner check ligaments the external and internal recti are tethered to the orbital walls (fig. 337, p. 153). All six muscles become tendinous at their insertions on the sclerotic. The four straight muscles are inserted in a line which encircles the eye 7 to 8 mm. ($\frac{1}{3}$ inch) behind the corneal margin (fig. 344). The *obliquus superior* is inserted on the upper surface beneath the rectus superior; its opponent, the *obliquus inferior*, is inserted rather nearer the optic nerve, beneath the rectus externus (fig. 344).

Origin of the Ocular Muscles.—The eyeball should now be removed from the orbit for further examination. The optic nerve, ciliary vessels and nerves, are cut half an inch behind the eye. The manner in which the ocular muscles arise should be investigated (fig. 345, and Plate LI, p. 152). A fibrous or tendinous ring (the *orbital collar*) will be found to surround the optic nerve and foramen and lower part of the sphenoidal fissure. The part of the ring which spans the fissure gives origin to both heads of the external rectus (fig. 343). The origin of the external rectus thus divides the sphenoidal fissure into an *upper compartment*, containing the lachrymal, frontal and trochlear (4th) nerves, and a *lower*, through which pass the other nerves to the orbit and the ophthalmic veins (fig 345). From the lower segment of the orbital collar arises the inferior rectus; from the upper, the superior rectus; from the inner, the internal rectus; while the obliquus superior arises above and to the inner side of the superior rectus. The origin of the inferior oblique has already been seen (Plate L, p. 130).

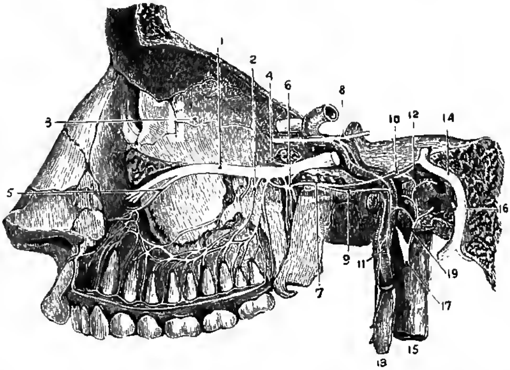
FIG. 345.—DIAGRAMMATIC REPRESENTATION OF ORIGINS OF OCULAR MUSCLES AT THE APEX OF THE RIGHT ORBIT. (*After Schwalbe, from Morris's 'Anatomy.'*)


Superior rectus
Fourth nerve
Levator palpebræ superioris
Lachrymal and frontal nerve
Origin of external rectus from fibrous bridge over sphenoidal fissure
Nasal branch of fifth nerve
Sixth nerve
External rectus
Third nerve
Inferior rectus
Superior oblique
Optic foramen and nerve
Internal rectus

Periorbital Membrane and Orbital Muscle.—When all the structures have been removed from the orbit, the periosteum (periorbital membrane) will be found to close the spheno-maxillary fissure. In some bodies, a distinct layer of non-striated muscle will be seen to cross the fissure (the Musculus orbitalis described by Müller). Its action is unknown; it is difficult to see how it could protrude the eye. It is supplied from the superior cervical ganglion. The periorbital membrane becomes continuous with the walls of the cavernous sinus in the sphenoidal fissure (fig. 330, p. 143); it is also continuous with the fibrous collar from which the ocular muscles arise. Its continuity with the palpebral membrane and sheath of the lachrymal sac has been already seen (figs. 330, p. 143, and 334, p. 148).

The **Superior Maxillary Nerve,** the second division of the fifth, has already been traced from the Gasserian ganglion to the foramen rotundum (p. 122). It should now be looked for as it escapes from the foramen to cross the spheno-maxillary fossa and enter the infra-orbital canal (fig. 346). The nerve should be exposed along the entire floor of the orbit by chiselling away the bone which surrounds it. It passes along the roof of the antrum of Highmore and ends in the skin of the cheek (p. 138).

FIG 346.—DISSECTION OF THE SUPERIOR MAXILLARY NERVE AND MECKEL'S GANGLION. (*From Hirschfeld and Leveillé.*)



1. Superior maxillary nerve. 2. Posterior dental nerves. 3. Inner wall of orbit. 4. Temporo-malar (cut). 5. Anterior dental nerve. 6. Meckel's ganglion. 7. Vidian nerve. 8. Sixth nerve. 9. Carotid branch of Vidian. 10. Superficial petrosal nerve. 11. Carotid plexus of sympathetic. 12. Lesser petrosal nerve. 13. Superior cervical ganglion. 14. Facial nerve. 15. Internal jugular vein. 16. Chorda tympani. 17. Glosso-pharyngeal nerve. 19. Jacobson's nerve.

Branches.—(*a*) To the *spheno-palatine* ganglion as it crosses the spheno-maxillary fossa (fig. 346). These branches will be examined afterwards. It also gives off in the fossa a recurrent *meningeal* branch and the one next described.

(*b*) The *Orbital* branch to the temporo-malar loop passes up on the outer wall of the orbit and unites with a branch from the lachrymal. From the loop thus formed arise the *malar* branches, which reach the skin of the cheek through two or three foramina in the malar bone and a *temporal* branch, which perforates the orbital plate of the malar and ends in the skin behind the external angular process.

(*c*) *Posterior dental*, to the three upper molar teeth. They pass out by the spheno-maxillary fissure and will be seen afterwards (fig. 346, 2).

(*d*) The *Middle dental* nerve passes down to the upper bicuspid teeth in the anterior and outer wall of the antrum.

(*e*) The *Anterior dental* ends in the upper canine and incisor teeth. It passes down in the anterior wall of the antrum (fig. 346, 5). These nerves may be followed from their origin in the infraorbital canal by chiselling away the overlying bone. The three dental nerves communicate and form a plexus in the alveolus (fig. 346). The anterior dental sends a branch to the anterior part of the floor of the nose (fig. 346).

DISSECTION OF THE EYE

The dissection of the eye is too important a matter to be deferred; besides, at this comparatively early stage in the dissection of the part, the eye should still be in good condition if the body has been prepared by a formalin injection.

The dissectors of the head and neck should arrange to dissect the two eyes together. The eyes should be divided with a razor or very sharp knife, one transversely in the equatorial line, the other in the median plane from back to front, so that the cornea and the entrance of the optic nerve are laid open (fig. 347). The study of these sections will give a very good conception of the anatomy of the eye. The student will find bullocks' eyes hardened in formalin very useful to verify certain details of structure, but it is on the human eye he must found his idea of shape and size.

Parts of the Eye (see fig. 347).

1. TUNICS or COATS.—Three tunics or coats are recognised in the eyeball:—

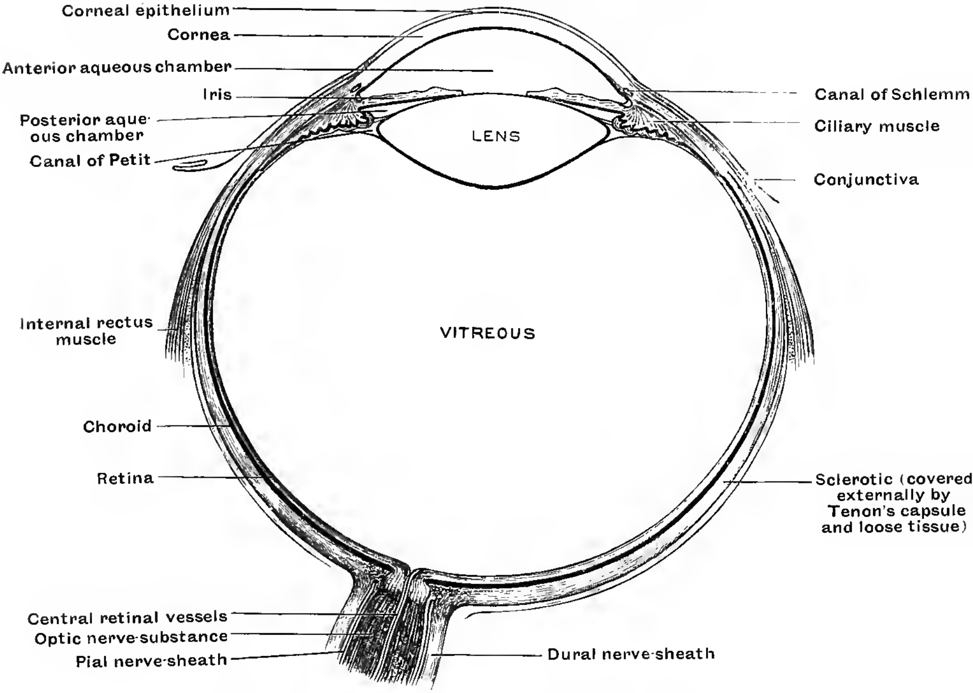
(*a*) An outer or protective, made up of the *Cornea* and *Sclerotic*.

(*b*) A middle or vascular, made up of the *Choroid*, *Ciliary bodies* and *Iris*.

(*c*) An inner or sensory coat, made up of the *Retina* and *Pars ciliaris retinæ*. The middle and inner coats are deficient anteriorly at the *Pupil*.

2. Chambers (fig. 347).—The cavity of the eyeball is divided by the *Lens* and its capsule into two compartments—the *Vitreous Chamber*, lined by the *Hyaloid Membrane*, containing the *Vitreous Humour*; and the *Aqueous Chamber*, containing the *Aqueous Humour*. The aqueous chamber is situated between the capsule of the lens and cornea; it is subdivided by the *Iris* into the *Anterior* and *Posterior chambers*.

Fig. 347.—Semi-diagrammatic horizontal section through eyeball and optic nerve. (*After Elfinger, from Morris's 'Anatomy.'*)



Conjunctiva.—Remnants of the ocular conjunctiva will be seen (fig. 347). It is firmly adherent at the circumference of the cornea, where the stratified epithelial covering of the conjunctiva becomes continuous with that of the cornea. Over the sclerotic, on the other hand, the conjunctiva is loosely attached by a lax connective tissue in which ramify branches of the anterior ciliary vessels, from which the cornea and conjunctiva obtain their nourishment (fig. 351, p. 170). These vessels often become bloodshot, especially during inflammatory conditions of the cornea.

The **Cornea**, as will be seen in the antero-posterior section, is a transparent part of the outer tunic or capsule of the eye. At the corneo-scleral junction it is continuous with the opaque fibrous sclerotic coat, the sclerotic overlapping the cornea at their bevelled union. The cornea is really a circular window in the outer tunic of the eye; it forms about one-sixth of that tunic. Above and below the sclerotic overlaps more than at the sides, and gives the cornea from without rather an oval form. The curvature of the cornea is important. In the normal eye it is curved almost equally in the horizontal and vertical planes, so that the rays of light which pass through these planes are equally refracted. In astigmatic eyes, on the other hand, the curvatures are unequal, with the result that when the rays in one plane are in focus, those of the other plane are not. The cornea is the segment of a smaller sphere than the sclerotic. Attention should be paid to the thickness of the cornea, as the incision to reach the iris and lens has to be made through it. It is only 1 mm. thick ($\frac{1}{25}$ inch), but as the surgeon passes his knife obliquely through it, parallel to the front of the iris, it appears then to be much thicker.

The blood-vessels for the cornea come from the anterior ciliary vessels and end at its circumference (fig. 351, p. 170). Only the lymph and leucocytes of the blood enter the cornea. They circulate in a peculiar system of lymph channels. The nerve supply of the cornea is derived from the long ciliary branches of the nasal nerve.

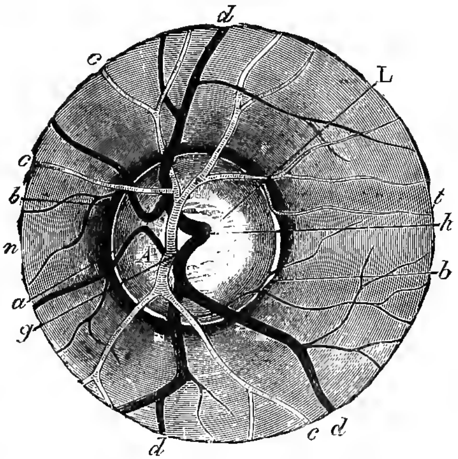
The **Sclerotic** forms a stout resisting outer tunic or capsule for the posterior five-sixths of the eyeball. The optic nerve perforates it at the lamina cribrosa; the dural sheath of the nerve becomes continuous with it at the point of perforation (fig. 347). The insertions of the ocular muscles fuse with it; the arteries, veins and nerves for the eyeball perforate it. In life, it is kept tense by the intra-ocular pressure. It is thickest round the entrance of the optic nerve, and thinnest behind the insertions of the ocular muscles. Its deepest layer is pigmented; it is separated from the coat beneath it, the choroid, by a lymph space.

Optic Disc.—In the fundus of the eyeball the optic nerve will be seen to appear and form the optic disc (figs. 347, 348).

From the disc the optic nerve-fibres radiate out on the inner surface of the retina. The disc is slightly hollow in the centre, with a raised circumference (fig. 349), but in glaucoma, when the intra-ocular tension becomes increased, the cribrosal part of the sclerotic gives way, and the disc has a punched-out appearance. The optic disc is whitish in appearance, insensitive to light, as it is not covered by rods and cones.

The **Central Artery** of the retina, a branch of the ophthalmic which reaches the eye in the optic nerve (fig. 339, p. 156), will be seen perforating at the optic disc. It divides as it appears in the fundus into an upper and a lower division (fig. 348). Each division again subdivides into a nasal and temporal branch. The yellow spot, the centre of acute vision, placed on the outer side of the disc, receives twigs from both temporal branches and also twigs from the main artery. The retina depends on the central artery for its blood supply. A corresponding vein leaves by the optic disc.

FIG. 348.—FUNDUS OF THE EYE AND OPTIC DISC. (*After Jaeger.*)

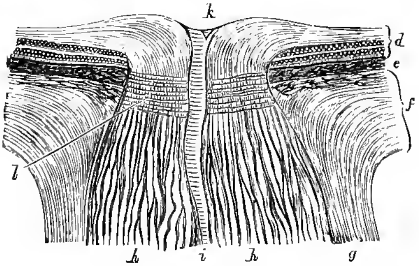


A. Optic disc. *b*, *b*. Choroidal ring. *c*, *c*. Retinal arteries. *d*, *d*. Retinal veins. *g*. Arteria centralis retinæ dividing. *h*. Venous radicles uniting to form a trunk. *n*. Inner side. *t*. Outer side. *L*. Physiological cup and lamina cribrosa.

In the fœtus the central artery is continued forwards in the vitreous humour to the capsule of the lens and a membrane which occludes the pupil (pupillary membrane). A fine fibrous remnant of the artery occasionally occurs in a canal within the vitreous (the canal of Stilling).

Retina.—The student should notice how easily the retina, which appears as a greyish semi-translucent lining to the vitreous chamber, can be detached, except at the optic disc, where the optic fibres radiate out into it. Detachment of the retina sometimes occurs in life. The layer of deeply pigmented retinal epithelium, in which the outer ends of the rods and cones are imbedded, adheres to the choroid when the retina is detached. The retina is so delicate that it scarcely bears the touch of forceps, and its appearance gives no indication of its extremely complex microscopic structure. The macula lutea with the fovea centralis, the centre of acute vision, is situated 3 mm. to the outer side of the optic nerve, directly in the antero-posterior axis of the eye (fig. 350, 8″). The macula lutea and fovea centralis is only present in animals with binocular vision, and is therefore absent in the eye of the ox. The metallic lustre seen in the fundus of the ox's eye is due to the *tapetum*, a structure not present in the human eye. The tapetum is a layer of fine fibres on the inner aspect of the choroid coat.

FIG. 349.—VERTICAL SECTION OF THE COATS OF THE EYE AT THE POINT OF ENTRANCE OF THE OPTIC NERVE. (*Ecker.*)



d. Retina. *e*. Choroid. *f*. Sclerotic. *g*. Outer sheath of the optic nerve. *h*. Fibres of the optic nerve. *i*. Central artery of the retina. *k*. Its point of subdivision. *l*. Lamina cribrosa.

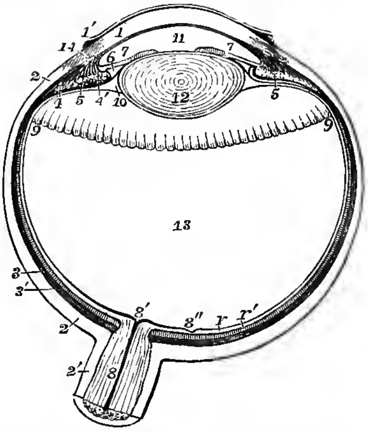
Pars Ciliaris Retinæ. The anterior part of the retina (pars ciliaris retinæ), which lies in the shadow of the iris, is pigmented, destitute of rods and cones and nervous elements, and therefore insensitive to light. Its junction with the sensitive part is marked by an indented line, the *ora serrata* (fig. 350, 9, 9).

The **Choroid** is the vascular coat of the eye (fig. 347, p. 165). On it the ciliary vessels and nerves pass forwards, the vessels ending in a fine capillary network (fig. 351). The capillary network is imbedded in a fibro-cellular tissue, containing many pigmented cells. It is easily separable from the sclerotic, a lymphatic space—the *supra-choroid*—being situated between the two coats. On its inner aspect it is in contact with the pigmented epithelial layer of the retina, in which the outer ends of the rods and cones are buried. On its outer surface venules converge to form the venæ vorticosæ (fig. 341, p. 158).

Ciliary Bodies.—Under the anterior part of the sclerotic, as may be seen in the antero-posterior sections, the choroid coat shows a circular series of thickenings—the ciliary processes or bodies (fig. 347, p. 165). These bodies (see figure 351) are supplied with blood from the anterior and posterior ciliary arteries, and each contains a rich network of capillaries. Wounds which involve the ciliary bodies or anterior scleral part of the eye are particularly dangerous, probably owing to the fact that the rich vascular and lymphatic network of the part gives infectious matter easy access to the whole of the choroid system. In the transverse section of the eye, the ciliary bodies will be seen to be about seventy in number, with their steep anterior extremities towards the iris, their sloping posterior ends pointing to the ora serrata (fig. 352). The ciliary bodies rest on the zonule of Zinn, which is continuous with the suspensory ligament of the lens. Their anterior extremities project within the aqueous chamber (fig. 347, p. 165).

The **Iris,** perforated by the pupil, is a circular curtain placed in front of the lens to cut off the peripheral rays of light. It is a continuation forwards of the ciliary part of the choroid, and is supplied from the anterior ciliary vessels (fig. 351) and nerves which supply both the dilator and constrictor fibres of the iris. It is covered posteriorly by a layer of pigmented cells (*uvea*), while others are scattered through its delicate fibrous and muscular substance (fig. 353). It is the number and colour of these latter cells which determine the hue of the eye. The iris contains circular muscular fibres which constrict the pupil, and radiating fibres which dilate it.

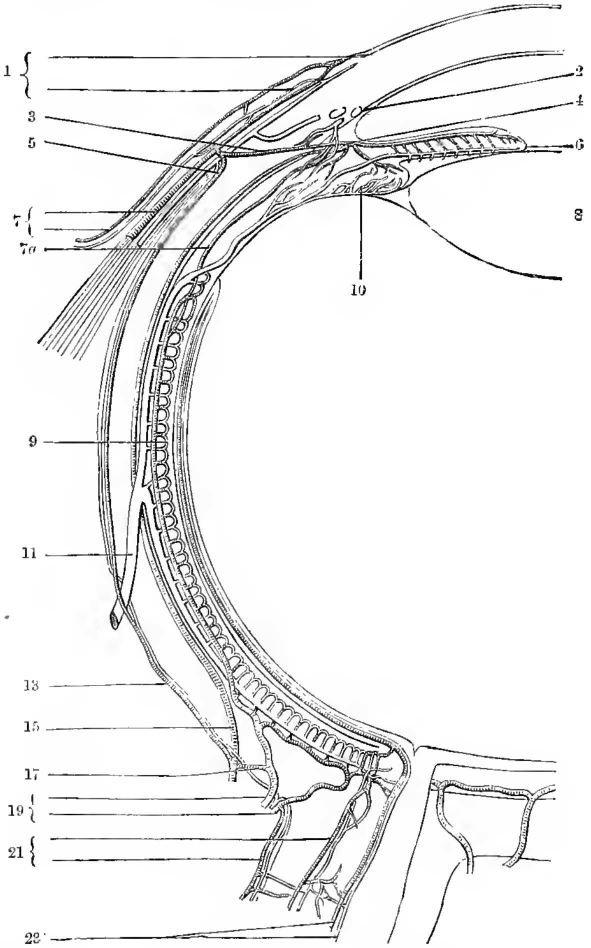
FIG. 350.—DIAGRAMMATIC SECTION OF THE EYE. (*Allen Thomson.*)



1. Cornea. 1'. Corneal conjunctiva. 2. Sclerotic. 2'. Outer sheath of the optic nerve, which is seen to be continuous with the sclerotic. 3. Vascular layers of the choroid. 3'. Pigmentary layer. 4. Radiating portion of the ciliary muscle. 4'. Cut fibres of circular portion, or *muscle of Müller*. 5, 5. Ciliary processes. 6. Posterior chamber of the aqueous humour. 7, 7. Iris. 8. Optic nerve. 8'. Optic disc. 8''. Yellow spot. 9. Ora serrata. 10. Canal of Petit. 11. Anterior chamber of the aqueous humour. 12. Crystalline lens. 13. Chamber of the vitreous humour. 14. Canal of Schlemm. *r*. Nervous layers of the retina. *r'*. Bacillary and molecular layers of the retina.

The **Ciliary Muscle** is seen in the antero-posterior sections of the eye rising from the corneo-scleral junction and radiating out into the anterior part of the choroid at the bases of the ciliary bodies (figs. 353 and 347). When examined microscopically the fibres are seen to be non-striated, and amongst the

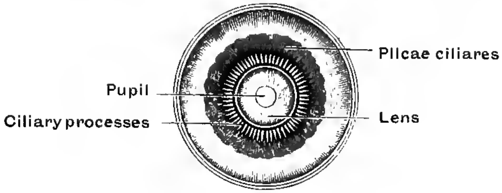
Fig. 351.—Scheme of circulation of the eye. (*After Leber.*)



1. Conjunctival vessels. 2. Sinus circulus venosus. 3. Anterior ciliary artery. 4. Greater arterial circle of iris. 5. Recurrent branch of anterior ciliary artery. 6. Iris. 7. Muscular and conjunctival vessels. 7*a*. Artery to ciliary processes. 8. Lens. 9. Chorio-capillaris. 10. Ciliary plexus. 11. Vena vorticosa. 13. Episcleral branch of long ciliary. 15. Deep branch of long ciliary. 17. Long ciliary artery. 19. Short ciliary artery. 21. Smaller retinal vessels. 23. Central vessels of retina.

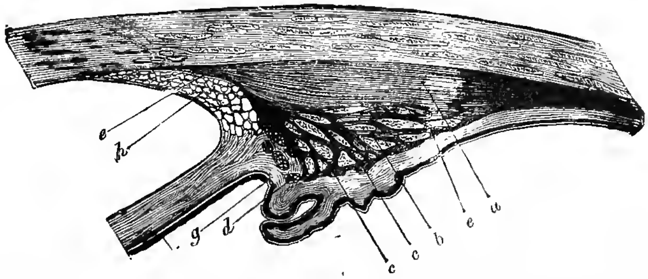
radial fibres are bundles arranged in a circular manner (fig. 353, 6), thus forming a sphincter round the ciliary part of the choroid. The fibres may be subsequently displayed by pulling away the iris and ciliary part of the choroid from the anterior half of the outer coat of the eye; they then appear as a greyish circle on the ciliary part of the choroid. By following this procedure the student will also see that the attachment of the iris and ciliary part of the choroid to the outer tunic of the eye is not strong, and blows on the eye occasionally cause them to become partially detached. Through its action on the ciliary part of the choroid, the ciliary muscle has the power to render the lens more convex and thus bring near objects to a focus on the retina.

FIG. 352.—EQUATORIAL SECTION OF EYEBALL: ANTERIOR SEGMENT VIEWED FROM BEHIND. (*After Merkel.*)



The LIGAMENTUM PECTINATUM IRIDIS (fig. 353, *h*) is a series of fine fibres which radiate from the inner margin of the corneo-scleral junction to the circumference of the iris. They cross the outer angle of the aqueous chamber. Between the fibres are a number of spaces—the SPACES OF FONTANA—which, as will subsequently be seen, are of the greatest importance.

FIG. 353.—SECTION OF THE CORNEO-SCLERAL JUNCTION SHOWING THE CILIARY MUSCLE. (*After Jevans.*)



a. Radiating fibres of the ciliary muscle. *b*. Circular fibres or muscle of Müller. *c*. Circular fibres surrounded by radiating fibres. *d*. Circular fibres by themselves. *e*. Muscular fibres shown in their connection with the corneo-sclerotic junction. *f*. Iris. *g*. Uveal tract. *h*. Ligamentum pectinatum.

The **Aqueous Chamber** is bounded behind by the lens and its capsule, and in front by the cornea (figs. 347, p. 165, and 330,

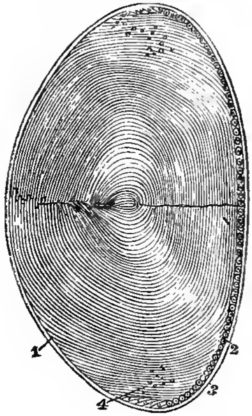
p. 143). It is through this chamber that the surgeon reaches the lens when that body has become opaque from cataract, so that its depth (3 mm. $=\frac{1}{8}$ in.) should be noted. The aqueous humour, which is being continually secreted and absorbed, fills the chamber. The chamber is subdivided by the iris into a SMALL POSTERIOR CHAMBER or compartment and a LARGER ANTERIOR (fig. 347). The anterior extremities of the ciliary bodies project beyond the circumference of the lens into the posterior compartment, and by these the aqueous humour is probably secreted. It passes into the anterior compartment by the pupil, and escapes through the spaces of Fontana to a circular canal—the canal of Schlemm—situated at the corneo-scleral junction (fig. 347), whence to the venæ vorticosæ in the choroid. It will be at once apparent that if the spaces of Fontana are occluded, as they are when the base of the iris is pressed against the circumference of the cornea, the egress of the aqueous humour is impeded, and that therefore the intra-ocular pressure is increased and, if prolonged, may lead to the destruction of the sensory part of the eye.

The **Vitreous Humour** is a transparent jelly-like tissue which completely fills the posterior (vitreous) chamber of the eye, and through which rays of light pass from the lens to the retina. It is composed of branching cells imbedded in a transparent matrix, and receives no blood-vessels. The canal of Stilling, a lymph path, passes through it from the lens to the optic disc. In the fœtus it contained the hyaloid artery.

The **Hyaloid Membrane** is a fine transparent membrane which forms a capsule for the vitreous humour and lies on the inner surface of the retina. The ZONULE OF ZINN is that segment of the hyaloid membrane on which the ciliary bodies rest. In front, as the membrane passes from the ciliary bodies to the margin of the lens, it divides and becomes continuous with the capsule of that body (fig. 350). That part of the hyaloid membrane between the circumference of the lens and the ciliary bodies is much thicker and stronger than the rest, and is distinguished as the SUSPENSORY LIGAMENT of the lens (as seen in antero-posterior section), for by means of it the lens is suspended and kept in position (fig. 347). A blow on the eye may rupture the ligament and cause dislocation of the lens. The CANAL OF PETIT is a space surrounding the circumference of the lens and within the fibres of the suspensory ligament (fig. 347).

When the anterior layer of the capsule is opened and the lens removed, the posterior wall of the capsule still bounds the vitreous humour and keeps it in position. It will be thus seen that the vitreous humour is encapsulated by (1) the hyaloid membrane; (2) the zonule of Zinn; (3) the suspensory ligament; and (4) the posterior layer of the capsule of the lens.

Fig. 354.—The crystalline lens. (*Babuchin.*)



1. The laminæ of which the lens is composed. 2. The cells contained between the capsule and front of the lens. 3. Capsule of the lens. 4. Nuclear zone.

The **Lens.**—It is almost impossible to make a satisfactory examination of the human lens from a dissecting-room subject. Its size, however, should be noted; it is 4 mm. ($\frac{1}{6}$ in.) thick and 8 mm. ($\frac{1}{3}$ in.) broad, and therefore requires a considerable corneal incision for its removal.

The posterior surface, which fits within the *fossa patellaris* on the vitreous, is more convex than the anterior surface (fig. 354). When the lens is cut, its centre is found to be much harder than its periphery; the cracks which occur when it is pressed are straight, owing to the linear arrangement of its fibres; its fibres are seen to be arranged in concentric layers.

The student should examine the manner in which the ciliary muscle and lens are connected (fig. 347, p. 165). By the action of the ciliary muscle the anterior surface of the lens becomes more convex.

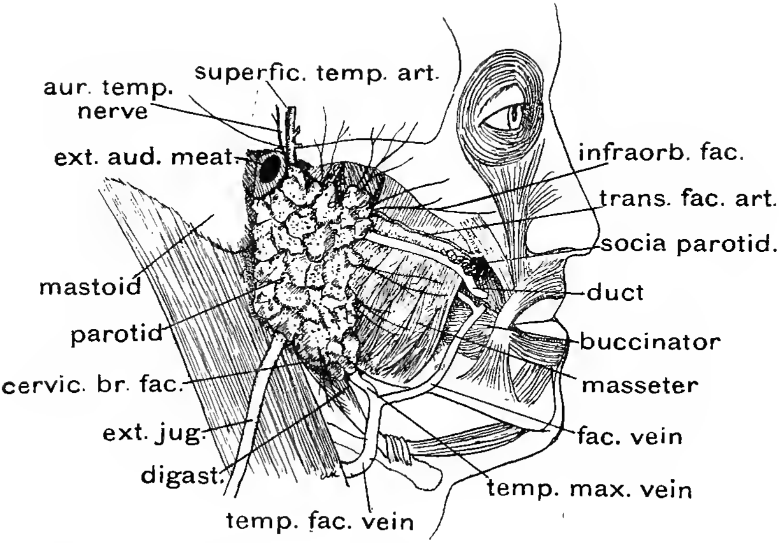
DISSECTION XI

THE PAROTID SPACE

The **Parotid Space,** which is now to be examined, is filled mainly by the Parotid Gland. Its boundaries and contents are best examined after the gland has been extracted (fig. 357).

The **Duct of the Parotid Gland** (Stenson's Duct) (fig. 355) crosses the masseter about half an inch below the zygoma and turns inwards at the anterior border of that muscle to perforate the buccinator. When the cheek is reflected from the upper jaw the narrow opening of the duct, raised on a slight papilla, will be found to be placed opposite the second upper molar tooth. There the saliva is poured out to mix with the food in the mouth. A line drawn from below the external meatus to a point on the upper lip midway between the nose and mouth lies over, and indicates for the surgeon the line of the duct on the masseter muscle. The transverse facial artery, with malar branches of the facial nerve, lies just above the duct. A semi-detached piece of the parotid (the Socia Parotidis), often visible in lean-faced people, lies with the duct over the masseter, while in front of that muscle the facial vein crosses the duct (fig. 355).

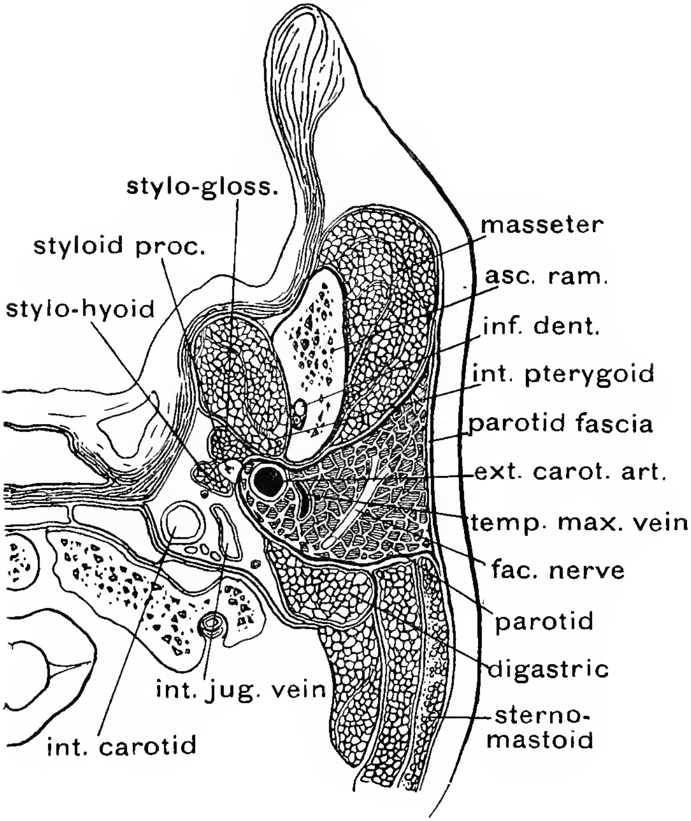
Fig. 355.—The Parotid gland and structures over the masseter



The **Facial Nerve** has already been exposed as it pierces and divides in the parotid (fig. 326, p. 135).

The **Parotid Gland** is very tightly bound within the space between the jaw in front and the mastoid process and origin of the sterno-mastoid behind (fig. 356). The fascia which covers it and forms the superficial part of its capsule is continuous with the fasciæ of surrounding regions, and binds the gland to the zygoma, to the tissues round the meatus, over the mastoid, to the sheath of the masseter, and, below, to the deep cervical fascia. Although seldom distinguishable during dissection, a number of lymphatic glands, situated in the tissue over the parotid gland, can be detected in diseases affecting the temporal and auricular regions.

FIG. 356.—A SECTION TO SHOW THE CONTENTS OF THE PAROTID SPACE. (*F. W. Jones.*)



The student should begin to raise the parotid gland at its lower part by separating it with the handle of his knife from the posterior belly of the digastric and stylo-maxillary ligament, on which it rests below. As he raises it upwards, the external carotid will be found entering and the temporo-maxillary vein emerging from its deep surface. The gland is pressed against the styloid process and the structures which arise from it (fig. 357). A deep process of the gland lies in front of the styloid; another dips in behind it. The separation of the external carotid artery and temporo-maxillary vein costs some trouble; the extraction of the gland from the glenoid cavity and floor of the external meatus, to which it is tightly bound, must be done with the handle of the knife and commonly in a piecemeal manner. Care has to be taken of the auriculo-temporal nerve, which supplies secretory fibres to the gland before it escapes in front of the ear between the root of the zygoma and parotid gland (fig. 357). The student will observe that, each time the mouth is opened, the gland and its secreted saliva must be compressed by the jaw. The relationship of the gland to the external auditory meatus explains the occasional escape of a parotid abscess by the external ear.

The **Parotid Space** will be seen to have the following boundaries (fig. 357):

Below—The posterior belly of the digastric and stylo-maxillary ligament.

Above—The posterior part of the glenoid fossa and external auditory meatus, tympanic plate and vaginal process.

In front—The masseter, ascending ramus of the jaw, and internal pterygoid (see fig. 356).

Behind—The mastoid process and insertion of the sterno-mastoid.

Floor—The more superficial contents of the deep or sub-parotid region. In the sub-parotid space are contained the internal jugular vein, the internal carotid artery, cranial nerves, IX. X. XI. and XII. and the superior cervical ganglion of the sympathetic (see fig. 357).

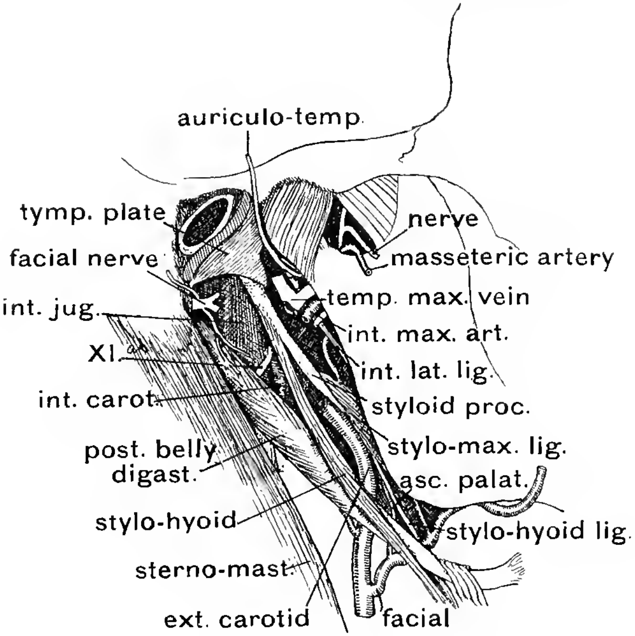
The **Contents of the Parotid Space** are (see fig. 356):

(*a*) The parotid gland.
(*b*) The facial nerve (p. 134).
(*c*) The temporo-maxillary vein.
(*d*) The terminal part of the external carotid artery.
(*e*) The auriculo-temporal nerve.
(*f*) The posterior auricular artery and nerve.
(*g*) The styloid process and the origins of the styloid muscles.

The TEMPORO-MAXILLARY vein is formed by the union of the internal maxillary and superficial temporal veins in the upper part of the parotid gland. Beneath the lower border of the gland it divides into a *posterior division*, which forms the commencement of the external jugular, and an *anterior*. This joins with the facial to form the temporo-facial vein which enters the internal jugular opposite the hyoid bone (see fig. 355).

The terminal part of the External Carotid enters the deep surface of the parotid gland; behind the condylar neck of the jaw it divides into Internal Maxillary and Superficial Temporal Arteries (fig. 291, p. 61).

Fig. 357.—The structures beneath the parotid gland.



The **Superficial Temporal Artery** emerges from the parotid in front of the ear, passes across the root of the zygoma, and ends in an anterior and posterior division over the deep temporal fascia (p. 99). It gives off:

(*a*) The Transverse Facial Artery, usually a small branch, which, rising within the gland, crosses the masseter above the parotid duct, to end in the structures of the cheek (fig. 355).

(*b*) The Middle Temporal, a twig which perforates the deep temporal fascia at the upper border of the zygoma and enters the temporal muscle.

(*c*) The ORBITAL, a small branch which passes forwards on the upper border of the zygoma between the two layers of the deep temporal fascia.

(*d*) ANTERIOR AURICULAR BRANCHES to the external ear and meatus.

The **Auriculo-Temporal Nerve** leaves the parotid space on the root of the zygoma, beneath and behind the superficial temporal artery. It enters the upper part of the space beneath the condyle of the jaw.

The **Styloid Process** crosses the space obliquely, pointing under the angle of the jaw. The *stylo-hyoid muscle* arises from its posterior aspect, near its root; the *stylo-glossus*, from the anterior aspect of its tip (fig. 374, p. 205). The *stylo-hyoid* ligament runs downwards from its tip; this ligament may become ossified, and the ossification has been mistaken for a foreign body in the lateral wall of the pharynx.

The STYLO-MAXILLARY ligament is a septum of deep cervical fascia, stretching between the styloid process and the angle of the jaw. It separates the parotid from the submaxillary salivary gland (fig. 357).

The POSTERIOR AURICULAR ARTERY, a branch of the external carotid, passes backwards and upwards above the posterior belly of the digastric (fig. 291, p. 61).

The POSTERIOR AURICULAR NERVE, a branch of the facial, lies beneath it. Both appear behind the ear, emerging between the parotid and mastoid process (fig. 357).

DISSECTION XII

THE MUSCLES OF MASTICATION.

Muscles of Mastication.—These include the following:—

1. Masseter.
2. Temporal.
3. External Pterygoid.
4. Internal Pterygoid.

With these also might be included those muscles which depress the jaw, move the tongue, lips, and cheek.

The **Masseter Muscle** covers the ascending ramus of the jaw (fig. 355). It will be at once apparent, from its attachments to the zygoma and lower jaw, that in action it will press the lower teeth firmly against the upper. The muscle consists of two parts, a larger anterior malar part and a smaller posterior temporal part. The origin of the malar part is by a strong tendinous sheet from the lower border of the malar bone and anterior part of the zygoma; the muscular fibres pass downwards and backwards to the outer aspect of the angle of the jaw and ascending ramus (Plate LII, p. 180). The temporal fibres arise directly from the posterior part of the lower border and root of the zygoma, and pass downwards and forwards beneath the malar fibres to the upper part of the outer aspect of the ascending ramus of the jaw. The deep fibres are continuous with the underlying fibres of the temporal muscle. The masseteric nerve from the third division of the Fifth, and the artery from the internal maxillary, enter the deep surface of the muscle (fig. 357). They pass through the sigmoid notch and will be seen in the dissection of the temporal muscle.

The **Temporal Fossa** is now to be freely opened. It is through this fossa that the surgeon gains access to the skull in operations on the Gasserian ganglion or middle meningeal artery. The strong DEEP TEMPORAL FASCIA, which roofs the space over, should be removed by cutting its attachments to the upper border of the zygoma, the posterior border of the malar and external angular process of the frontal (see fig. 305, p. 100). Its attachment to the upper of the two temporal ridges has already been cut. To completely expose the temporal muscle which fills the fossa, the zygoma is to be cut through with a saw in front of and behind the origin of the masseter muscle and then turned down on the cheek, with the muscle still attached. As it is raised the masseteric vessels and nerve will require to be cut.

The **Temporal Muscle** has a wide fan-shaped origin from (*a*) the bones forming the floor of the temporal fossa, (*b*) the lower of the two temporal ridges, (*c*) the posterior border of the malar and external angular process of the frontal, (*d*) the inner aspect of the root of the zygoma, (*e*) the deep temporal fascia.

From a wide origin the fibres converge to their insertion on (*a*) a flat tendon which is attached to the apex and anterior border of the coronoid process; (*b*) the inner aspect of the coronoid; (*c*) by a rounded tendon to the ascending ramus of the jaw, behind and external to the last lower molar. It is a biting and chewing muscle, and may be seen bulging outwards in the temporal fossa when the lower jaw is tightly closed.

The **Deep Temporal Vessels and Nerves** will be found beneath the temporal muscle on the floor of the temporal fossa (figs. 364 and 365). To see them the coronoid process should be cut through at its base with a pair of stout bone forceps, and turned upwards with the insertion of the temporal muscle still attached to it. The temporal muscle should be completely removed from the temporal fossa, from below upwards, by using the handle end of the knife, the nerves and arteries being carefully guarded as the muscle is raised. The muscle will be found to have a strong aponeurotic origin from the infra-temporal crest which bounds the temporal fossa below, and, as may be verified on the skull, separates it from the zygomatic fossa below, containing the external pterygoid muscle. Between the muscle and the outer wall of the orbit will be found a quantity of fat, which, when absorbed in wasting diseases, leaves a hollow space on the temple.

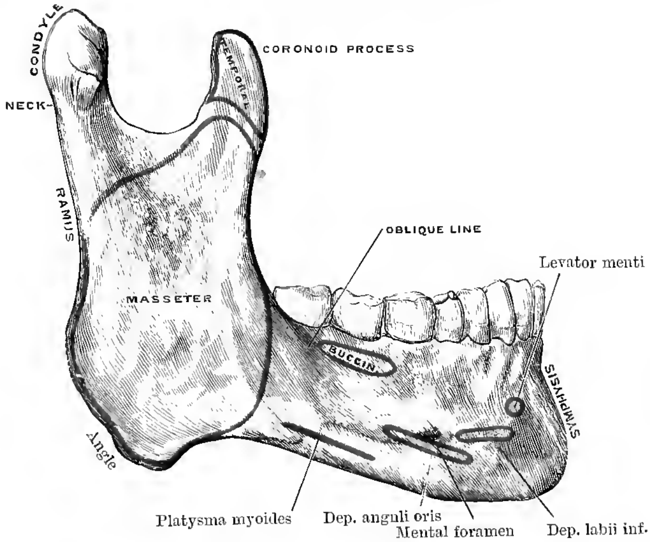
The DEEP TEMPORAL NERVES (fig. 365, p. 189), branches of the third division of the Fifth, supply the temporal muscle and are three in number. The *Posterior* appears above the insertion of the external pterygoid in common with the nerve for the masseter; the *Anterior* escapes with the long buccal between the two heads of the external pterygoid, and then turns upwards beneath the anterior part of the temporal muscle. The *Middle* appears between the anterior and posterior at the upper border of the upper head of the external pterygoid.

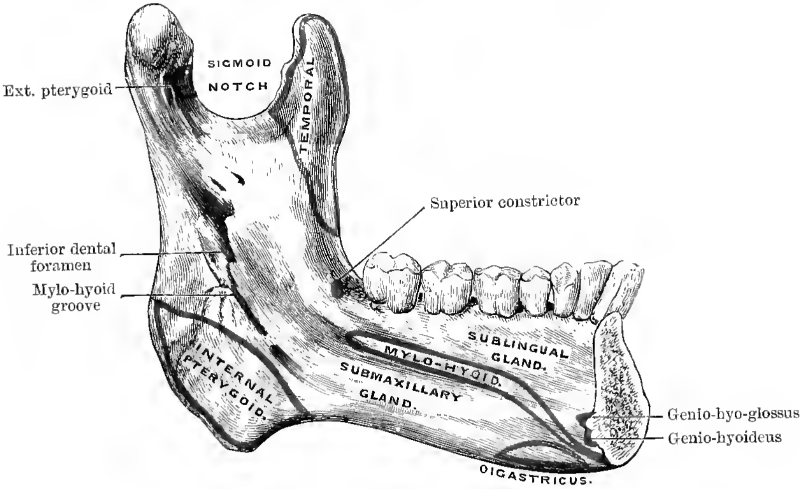
The ANTERIOR and POSTERIOR DEEP TEMPORAL ARTERIES are branches of the Internal Maxillary (fig. 364, p. 187). The *Middle* is a branch from the Superficial Temporal artery (fig. 327, p. 137).

Zygomatic Fossa and its Contents.—The boundaries of the Zygomatic Fossa are indicated in figure 358, and should now be verified by the dissectors on a skull. The fossa and its contents have already been exposed by the reflection of the zygoma, the masseter and coronoid process, but in order to fully expose it a further part of the ascending ramus of the lower jaw should be removed. A saw-cut should be made across the jaw, so as to detach the condyle and neck, and

PLATE LII

THE MUSCULAR ATTACHMENTS TO THE LOWER JAW. (*H. E. Clark.*)



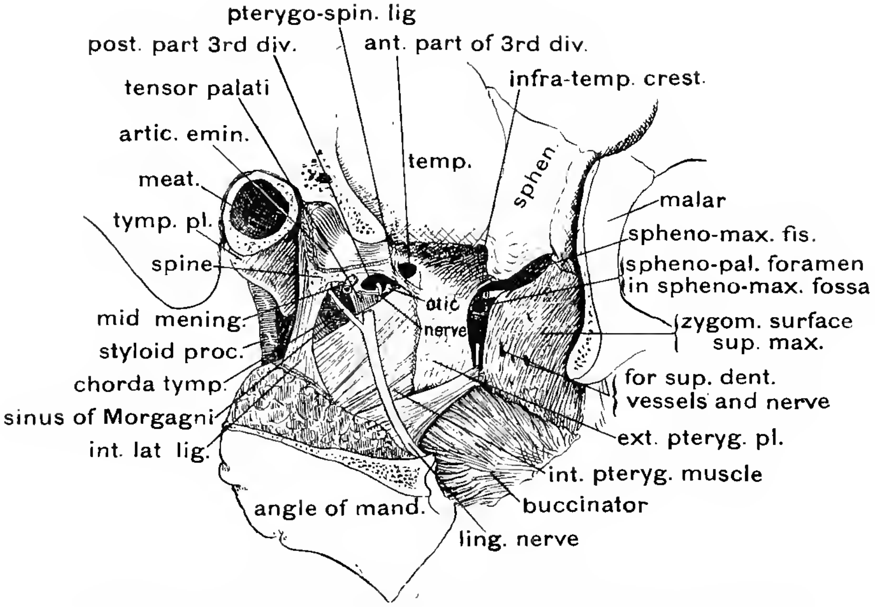


then another nearer the angle of the jaw, so that a part of the ascending ramus, about one inch in extent, may be carefully raised from the underlying structures and removed. The dissector should then be able to make out the following boundaries of the fossa :

(*a*) *In front*, the zygomatic surface of the superior maxilla ;

(*b*) *Above*, the infra-temporal crest separating it from the temporal fossa (Plate LI, p. 152) ;

Fig. 358.—A dissection to show the boundaries and floor of the zygomatic space.



The positions of the nerve to the internal pterygoid muscle (see Nerve on external pterygoid plate) and of the otic ganglion are indicated.

(*c*) Its *deep boundary* or *floor*, which will be examined subsequently, is formed partly by the external pterygoid plate.

The *foramen spinosum*, for the middle meningeal artery, the *foramen ovale* for the third division of the Fifth, and the *spheno-maxillary fossa*, in which the internal maxillary artery disappears, all open on the fossa. In the depth of the spheno-maxillary fossa is the spheno-palatine foramen, by which vessels and nerves gain access to the nasal cavity.

In the recent body, the floor of the zygomatic fossa, formed by the external pterygoid plate as seen in the macerated skull, is extended and completed by the internal pterygoid muscle and internal lateral ligament of the jaw (fig. 358). It is convenient to distinguish the space between those three structures forming the floor internally and the ascending ramus and masseter forming the roof externally as the *Zygomatic Space.*

The **Contents of the Zygomatic Space** are:

(1) The External Pterygoid Muscle (fig. 364);

(2) The Internal Maxillary Artery and Branches (fig. 364);

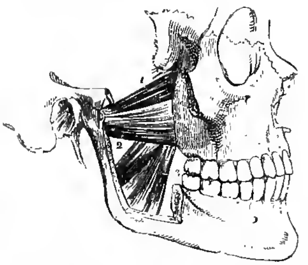
(3) The Pterygoid Plexus of Veins;

(4) The Third Division of the Fifth Nerve and its branches (fig. 365);

(5) The Otic Ganglion.

The **External Pterygoid** muscle is difficult to define clearly, owing to the connective tissue and pterygoid plexus of veins which surround it. Its fibres are easily torn. With almost equal frequency the internal maxillary artery passes under or over its lower head of origin. If the artery is superficial, the dissector will have to exercise some care as he cleans the muscle. Its origin is by two heads (fig. 359 and Plate LI, p. 152): an *upper*, from the outer surface of the great wing of the sphenoid below the infra-temporal crest; a *lower*, from the outer surface of the external pterygoid plate. The fibres pass backwards and slightly outwards to be inserted to a fossa on the anterior aspect of the neck of the condyle, and also to the capsule and inter-articular cartilage of the temporo-maxillary articulation (fig. 364).

FIG. 359.—THE EXTERNAL AND INTERNAL PTERYGOID MUSCLES. (*Wilson.*)



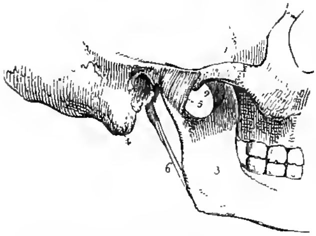
The zygomatic arch and the greater part of the ramus of the lower jaw have been removed in order to bring these muscles into view. 1. The upper or sphenoid head of the external pterygoid. 2. Its lower or pterygoid head. 3. The internal pterygoid.

From the direction of its fibres, it will be evident that when the muscle of one side *contracts*, the condyle and inter-articular cartilage will be pulled forwards and the chin moved towards the opposite side; if both muscles contract, then the chin will be shot outwards and the lower molars ground against the upper. But to fully understand its action the temporo-maxillary articulation should now be examined.

Temporo-Maxillary Articulation.—The External Lateral Ligament (fig. 360) is extremely strong, and passes downwards and backwards on the outer aspect of the joint. It is attached to a tubercle on the outer aspect of the zygoma above the articulation, and to the outer and posterior aspect of the neck. It forms the strongest part of the capsule of the joint, and, while allowing the condyle to move forwards, resists any posterior dislocation.

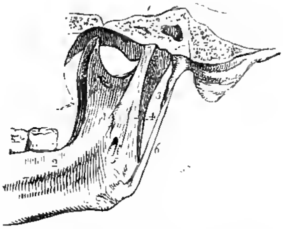
The Posterior Ligament is a lax part of the capsule attached above to the Glaserian fissure and post-glenoid spine, and below to the posterior aspect of the neck.

Fig. 360.—The external lateral ligament of the temporo-maxillary articulation. (*Wilson.*)



1. Zygomatic arch. 2. Tubercle of the zygoma. 3. Ramus of the lower jaw. 4. Mastoid portion of the temporal bone. 5. External lateral ligament. 6. Stylo-maxillary ligament.

Fig. 361.—The long internal lateral or spheno-mandibular ligament of the temporo-maxillary articulation. (*Wilson.*)



1. Section through the petrous portion of the temporal bone and spinous process of the sphenoid. 2. Internal surface of the ramus and body of the lower jaw. 3. Capsular ligament. 4. Long internal lateral ligament. 5. A small interval at its insertion through which the mylo-hyoid nerve passes. 6. Stylo-maxillary ligament, a process of the deep cervical fascia.

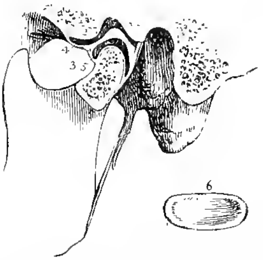
The Capsule of the joint, while strengthened on the outer and posterior aspects by the ligaments mentioned above, is extremely lax internally and anteriorly (fig. 363).

The strength of the muscles which surround the joint secures it, but two accessory ligaments, the long internal lateral (p. 184) and stylo-maxillary (p. 178), also assist in limiting its movements (see figs. 361 and 358).

The Inter-articular Fibro-cartilage or Meniscus (figs. 362, 363, and 364) may be seen most clearly by cutting away the external lateral ligament and lightly pulling the condyle downwards. The Meniscus separates the cavity of the joint into a larger upper and a smaller lower compartment. Behind and above it is attached through the capsule to the Glaserian fissure and post-glenoid spine, while in front and laterally it is attached to the capsule and through it to the neck of the condyle. Its oval shape, with its long axis placed transversely, fits the articular surface of the condyle.

The action of the external pterygoid will now be apparent. When it contracts it pulls both condyle and meniscus forwards, the movement taking place in the upper compartment (fig. 364). This movement occurs every time the mouth is opened, the condyle moving forwards till it rests on the articular eminence. The movement in the lower compartment of the joint is one of pure rotation between the condyle and meniscus. In dislocation of the jaw, the condyle and meniscus slip over and lie in front of the articular eminence and the jaw is fixed in a hyper-extended position. The dislocation may be produced by muscular action, as in yawning. The capsule in front is lax, and the arrangement of the ligaments does not prevent such a forward dislocation.

FIG. 362.—SECTION OF THE TEMPORO-MAXILLARY ARTICULATION TO SHOW THE MENISCUS. (*Wilson.*)



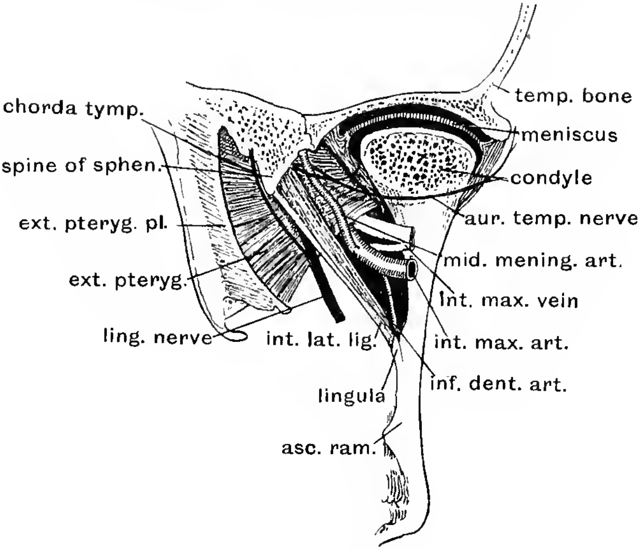
1. Glenoid fossa. 2. Eminentia articularis. 3. Interarticular fibro-cartilage. 4. Superior synovial cavity. 5. Inferior synovial cavity. 6. An interarticular fibro-cartilage, removed from the joint in order to show its oval and concave form ; it is seen from below.

STRUCTURES IN CONTACT WITH THE TEMPORO-MAXILLARY ARTICULATION (fig. 363).—The joint is sometimes the seat of abscess, and, unlikely as it may appear, the condyle may become ossified to the skull, and require to be operated on. Attention should therefore be paid to the structures which surround it. The capsule should be cut through, and the condyle, with the external pterygoid still attached to it, raised and turned forwards. Behind the joint is the external auditory meatus, tympanic plate, and parotid gland. Its outer surface is covered only by superficial structures. In the connective tissue, deep to the articulation and neck of the condylar process, will be found the auriculo-temporal nerve and the maxillary vessels (fig. 363).

The LONG INTERNAL LATERAL or SPHENO-MANDIBULAR LIGAMENT (figs. 361 and 358) of the Temporo-maxillary articulation will be found deep to the structures just mentioned.

It is a flat band of fibrous tissue, not of great strength. Above, it is attached to the spine of the sphenoid, and below to the lingula, at the opening of the dental canal on the inner aspect of the ascending ramus (Plate LII, p. 180). It forms the posterior part of the floor of the zygomatic space (fig. 358). The space between the ligament and the neck of the jaw forms a passage between the parotid and zygomatic spaces (see figs. 357 and 363). Through this portal pass the auriculo-temporal nerve, the internal maxillary artery, internal maxillary vein, lymphatics, and occasionally a process of the parotid gland.

Fig. 363.—The passage between the parotid and zygomatic spaces with the structures passing through it (viewed from behind).



The **Internal Maxillary Artery** is one of the terminal branches of the external carotid, and enters the zygomatic space from the parotid, at the passage described above (fig. 363). It supplies the walls and contents of the zygomatic, temporal and nasal fossæ, and a large part of the dura mater and calvarium.

It is convenient to notice three stages in the course of the internal maxillary (fig. 364); the *first*, from its origin to the lower border of the external pterygoid; the *second*, beneath or superficial, as the case may be, to the lower head of that muscle; the *third*, beyond the lower head of the external pterygoid. The third and final stage lies over and in the spheno-maxillary fossa (fig. 364). The branches from the first and third stages, almost without exception, leave the zygomatic space by bony foramina or canals, while the branches from the second stage end in the muscles and surrounding soft structures.

Branches from the First Stage.—(*a*) The MIDDLE MENINGEAL is by far the most important branch of the internal maxillary, and should be looked for first. It passes up beneath the posterior part of the external pterygoid and enters the skull at the foramen spinosum, which will be seen to lie just in front of the spine of the sphenoid and attachment of the long internal lateral ligament (fig. 363). It is surrounded by the two roots of the auriculo-temporal nerve. It supplies the dura mater and inner aspect of the skull (see fig. 318, p. 120).

(*b*) The SMALL MENINGEAL (fig. 364) is a twig that enters the skull at the foramen ovale and ends in the dura mater of the middle fossa and Gasserian ganglion.

(*c*) The MEATAL or AUDITORY and TYMPANIC branches pass upwards and backwards behind the temporo-maxillary articulation. The first enters the external auditory meatus, the second reaches the tympanum through the Glaserian fissure (figs. 364 and 311, p. 107).

(*d*) The INFERIOR DENTAL ARTERY is also of considerable size. It passes downwards to enter the dental canal with the inferior dental nerve, which lies in front of it (figs. 363 and 364). It supplies the jaw and the pulp cavities of the lower teeth ; a *mental* branch emerges at the mental foramen and ends in the lower lip (fig. 327, p. 137). Its *mylo-hyoid* branch arises above the dental foramen and passes downwards with the corresponding nerve above the insertion of the internal pterygoid muscle. It ends between the jaw and mylo-hyoid muscle.

Branches of the Second Stage (fig. 364).

(*a*) The ANTERIOR and POSTERIOR DEEP TEMPORAL arteries pass upwards beneath the temporal muscle, in which they end.

(*b*) The MASSETERIC branch has already been seen entering the Masseter (fig. 357).

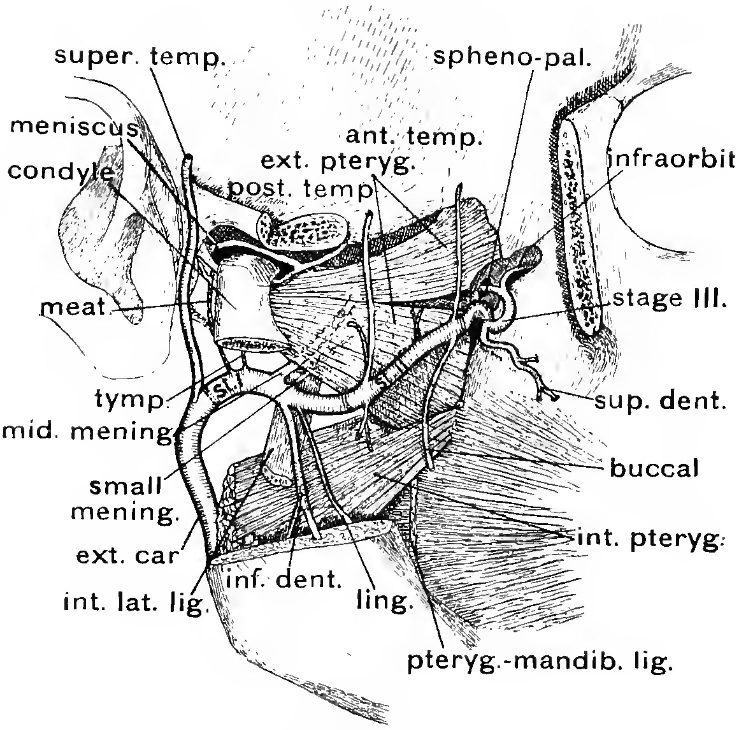
(*c*) The PTERYGOID branches pass to the external and internal pterygoid muscles.

(*d*) The BUCCAL branch passes forwards over the buccinator muscle to end in the cheek.

Branches of the Third Stage.—Only some of these can be satisfactorily examined at present; the others will be described with the parts which they supply.

(*a*) The Infra-orbital branch will be found in the spheno-maxillary fossa, entering the orbit by the spheno-maxillary fissure, and passing forwards in the floor of the orbit with the superior maxillary nerve in the infra-orbital canal (fig. 364). Its terminal part emerges at the infra-orbital foramen and ends in the structures of the cheek, forming anastomoses with the other arteries of the face (fig. 327, p. 137). Branches accompany all the ramifications of the infra-orbital nerve. Its anterior and middle dental branches pass in the wall of the antrum to supply the incisor, canine, and bicuspid teeth. The superior maxilla and lining membrane of the maxillary antrum are supplied by twigs from the infra-orbital artery.

Fig. 364.—The stages and branches of the internal maxillary.
(*W. R. M. Turtle.*)



(*b*) The Posterior Dental artery supplies the upper molar teeth, and will be found entering canals on the zygomatic aspect of the superior maxillary (fig. 364).

(*c*) The SPHENO-PALATINE branch, which enters the nasal cavity by the spheno-palatine foramen (fig. 358); (*d*) the PALATINE, which descends in the posterior palatine canal; and (*e* and *f*) the small VIDIAN and PTERYGO-PALATINE branches cannot be followed satisfactorily at present.

PTERYGOID PLEXUS OF VEINS.—The veins, which accompany and return the blood of the branches of the internal maxillary artery, end in a plexus which closely surrounds the external pterygoid muscle, and which cannot be defined distinctly unless a special injection of the veins is made. The plexus receives three communicating trunks of note: (*a*) the *deep facial* vein, which lies on the buccinator muscle and joins the facial vein (fig. 307, p. 102); (*b*) an *orbital* vein, which communicates with the ophthalmic through the spheno-maxillary fissure (fig. 336, p. 151); (*c*) the *Vesalian*, an emissary vein from the cavernous sinus, which, however, is only occasionally present.

The pterygoid plexus receives the meningeal veins through the foramen spinosum and foramen ovale. The blood within the plexus passes out by the INTERNAL MAXILLARY vein and joins in the parotid gland with the superficial temporal to form the temporo-maxillary vein (fig. 357, p. 177).

Third or Mandibular Division of the Fifth Cranial Nerve. When the origin of the external pterygoid is raised by the handle of the knife, and the muscle and the condyle of the jaw with the first and second stages of the internal maxillary artery completely removed, the third division of the Fifth can be made out clearly. As the division issues from the foramen ovale beneath the external pterygoid it will be seen to be divided into a small ANTERIOR or SUPERFICIAL and a large POSTERIOR or DEEP group of branches by the spino-pterygoid ligament (fig. 358). This slender ligament, sometimes partly muscular, sometimes converted into bone, passes forwards from the spine of the sphenoid to the base of the external pterygoid plate. The greater part of the motor root of the fifth nerve passes into the anterior or superficial group of branches.

Anterior Group of Branches of the Third Division of the Fifth.

(*a*) The LONG BUCCAL (fig. 365, 8), a sensory nerve, appears between the two heads of the external pterygoid and ends in the mucous membrane and skin of the cheek (p. 139).

(*b*) The Anterior Temporal appears between the two heads of the external pterygoid with the last nerve and ends in the temporal muscle (fig. 365, 6).

(*c*) The Middle Temporal (fig. 365, 5) is placed between the anterior and posterior. It appears at the upper border of the external pterygoid and ends in the temporal muscle.

(*d*) The Posterior Temporal passes upwards between the skull and the external pterygoid to end in the temporal muscle (fig. 365, 7).

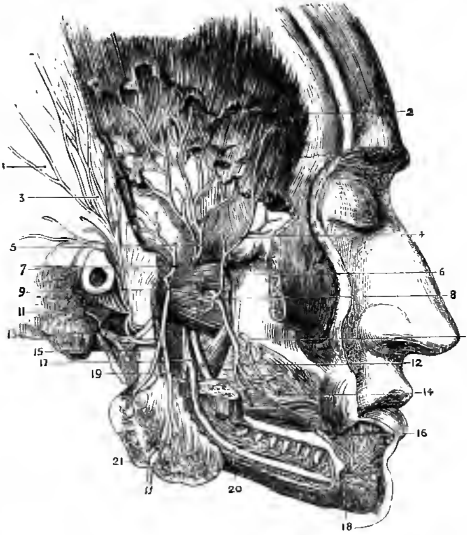
(*e*) The Masseteric rises with the last (fig. 365, 9) and reaches the deep surface of its muscle through the sigmoid notch (fig. 357).

(*f*) The External Pterygoid branch passes directly to the deep surface of its muscle.

Branches of the Deep Group.

(*a*) The Inferior Dental Nerve courses downwards and backwards to enter the dental canal of the lower jaw (fig. 365, 17). In this stage of its course it could be reached in operative procedures by cutting through the masseter and trephining the ascending ramus. It rests on the floor of the zygomatic space, internal pterygoid and insertion of the internal lateral ligament, and is crossed by the external pterygoid muscle and internal maxillary vessels. Just before

Fig. 365.—The nerves of the zygomatic space. (*Hirschfeld and Leveillé.*)



1. Temporal fascia. 2. Temporal muscle. 3. Tempora branches of auriculo-temporal nerve. 4. Anterior deep temporal nerve. 5. Posterior deep temporal nerve. 6. External pterygoid muscle. 7. Deep temporal branch of masseteric nerve (inconstant). 8. Buccal nerve. 9. Masseteric nerve. 10. Buccal branch of seventh. 11. Auriculo-temporal nerve. 12. Lingual nerve. 13. Facial nerve at stylo-mastoid foramen. 14. Buccinator muscle. 15. Internal pterygoid. 16. Infra-maxillary branch of seventh. 17. Inferior dental nerve. 18. Its mental branches. 19. Its mylo-hyoid branch. 20. Inferior dental canal opened. 21. Masseter (turned down).

entering the dental canal it gives off the *Mylo-hyoid* nerve (fig. 365, 19), which, passing down between the insertion of the internal pterygoid and mandible, reaches the sub-maxillary space, where it ends in the anterior belly of the digastric and mylo-hyoid muscles (fig. 373). The inferior dental nerve, as it runs forwards in the dental canal, gives off branches to the pulp cavities and peridental membranes of all the lower teeth. Opposite the roots of the bicuspid teeth, its mental branch leaves the canal by the mental foramen and supplies sensory fibres to the structures of the lower lip (fig. 365, 18). The nerve should be exposed in the dental canal by chiselling away the outer lamina of the jaw.

(*b*) The AURICULO-TEMPORAL NERVE (fig. 365) arises by two roots which enclose the middle meningeal artery as that vessel enters the foramen spinosum. It passes backwards to the parotid space internal to the temporo-maxillary articulation, which it supplies with sensory fibres ; it gives twigs to the parotid gland which contain secretory fibres obtained through the otic ganglion, and, passing upwards over the root of the zygoma in front of the ear, ends in the lateral and upper aspects of the scalp (fig. 311, p. 107). A branch ends in the external ear.

(*c*) The LINGUAL NERVE is the sensory pathway for the anterior two-thirds (buccal part) of the tongue (fig. 365, 12). To obtain a clear conception of its rather complicated course, the student should observe in it three distinct stages.

In the *first stage*, the nerve lies in the zygomatic space between the internal pterygoid and ascending ramus of the jaw. It may be exposed there by dividing the masseter and the ascending ramus (fig. 358, p. 181).

The *second stage* lies in the submaxillary space (fig. 373, p. 203). At the commencement of this stage the nerve may be reached by cutting through the buccal mucous membrane half an inch behind and below the last lower molar (fig. 376, p. 210).

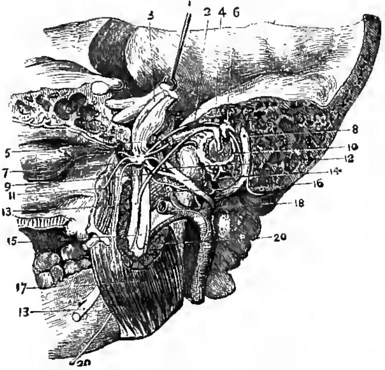
The *third stage* lies in the sublingual space, beyond the hyoglossus muscle (fig. 378, p. 212). Only the first stage can be examined now.

The CHORDA TYMPANI, a branch of the facial, will be seen to join the posterior border of the lingual nerve about three-quarters of an inch below the foramen ovale (fig. 358, p. 181). It may be traced backwards and upwards for about an inch to the inner side of the spine of the sphenoid, on which it gives rise to a groove (Lucas). It crosses the tympanum to reach this point (fig. 366). The relationship of the chorda within the tympanum will be seen when the middle ear is dissected (p. 277). It contains secretory fibres for the submaxillary and sublingual glands, and probably taste fibres for the anterior part of the tongue.

(*d*) Nerve of the Internal Pterygoid.—All the branches of the third division of the Fifth should now be cut through about half an inch below the foramen ovale. When the emerging trunk is carefully lifted outwards, the nerve for the internal pterygoid will be found passing downwards and forwards in loose connective tissue to enter the muscle at the upper part of its posterior border (fig. 358, p. 181).

Otic Ganglion.—When the nerve to the internal pterygoid is followed upwards, it will be found to be connected with the otic ganglion (fig. 366, 7). The ganglion lies close to the foramen ovale, deep to the third division, and superficial to the tensor palati muscle (fig. 358, p. 181). It is of small size, about equal to that of a grape-seed, and difficult to discover in the loose connective tissue which surrounds it. *Motor fibres* enter it from the internal pterygoid nerve; the small superficial petrosal nerve (p. 277), derived from the facial and glosso-pharyngeal, enters it behind and supplies *sensory* and perhaps other fibres (fig. 366, 5); *sympathetic fibres* (vaso-motor) pass to it from the plexus on the middle meningeal artery (fig. 366, 12).

Fig. 366.—The third division of the fifth and the otic ganglion viewed on their deep surfaces. (*Hirschfeld and Leveillé.*)



1. Sensory portion of fifth nerve, with Gasserian ganglion. 2. Tensor tympani. 3. Motor portion of fifth, passing beneath ganglion. 4. Malleus. 5. Small superficial petrosal nerve. 6. Incus. 7. Otic ganglion. 8. Facial nerve. 9. Chorda tympani. 10. Membrana tympani. 11. Tensor palati. 12. Middle meningeal artery. 13, 13. Lingual nerve. 14. Auriculo-temporal nerve. 15. Inferior dental nerve. 16. External pterygoid. 17. Internal pterygoid. 18. Internal maxillary artery. 20, 20. Mylo-hyoid nerve.

The otic ganglion gives off the following branches (fig. 366):

(*a*) To the *tensor palati muscle*, the muscle lying deep to the ganglion (fig. 366, 11).

(*b*) To the *tensor tympani* which lies in the roof of the Eustachian tube behind the ganglion (fig. 366, 2).

(*c*) To the *chorda tympani* (fig. 366, 9).

(*d*) To the *auriculo-temporal* nerve (secretory fibres for the parotid) (fig. 366, 14).

(*e*) A *meningeal twig* which enters the skull at the foramen spinosum.

A recurrent meningeal branch from the third division of the Fifth should be sought for as it enters the skull by the foramen ovale.

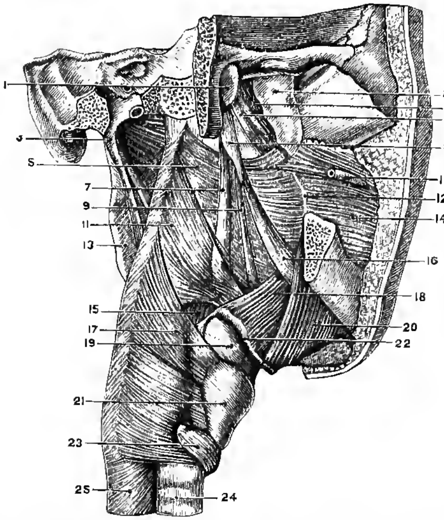
The soft structures which assist to form the floor of the zygomatic space (p. 182), and separate the space from the wall of the pharynx, can now be examined (fig. 358, p. 181). They are: (1) The internal pterygoid; (2) the tensor palati; (3) the superior constrictor; (4) the fibrous hiatus of the pharynx (sinus of Morgagni), in which the Eustachian tube, levator palati, and pharyngeal aponeurosis are seen. Further back (5) the long internal lateral ligament of the jaw (already described). The ascending palatine and tonsillar arteries are also to be observed (fig. 369).

The **Internal Pterygoid Muscle** arises by tendinous and fleshy fibres from the pterygoid fossa, with a superficial extension from the superior maxillary bone (fig. 358). It is inserted on the inner aspect of the ascending ramus at and above the angle of the jaw (Plate LII, p. 180). It will be seen from the downward and slightly backward direction of the fibres that its action, like that of the masseter, is to raise the lower jaw and press the lower molar teeth against the upper, with, at the same time, a slight forward movement. Its nerve enters the upper part of the posterior border of the muscle, and is derived from the trunk of the third division of the fifth nerve.

The internal pterygoid is now to be completely removed by clearing out its origin from the pterygoid fossa, and removing its insertion and what remains of the ascending ramus, by means of a vertical saw-cut behind the last molar tooth. The internal lateral and stylo-maxillary ligaments had better be removed with it.

Structures beneath the Internal Pterygoid.—Beneath the internal pterygoid muscle, covered by loose connective tissue, will be found the superior constrictor (fig. 367, 5). Under the anterior border of the muscle will be found the pterygo-maxillary ligament from which the constrictor fibres arise to pass backwards, and the buccinator to pass forwards (fig. 367, 12). On the inner aspect of the superior constrictor, beneath the insertion of the pterygoid muscle to the angle of the jaw, is situated the tonsil, which will thus be seen to be practically inaccessible for operation from the neck. The stylo-hyoid ligament and stylo-glossus muscle also pass beneath the internal pterygoid (fig. 367, 16).

Fig. 367.—The muscles of the pharynx, especially those beneath the internal pterygoid. (*Sappey.*)



1. Eustachian tube. 2. External pterygoid plate. 3. Left styloid process. 4. Tensor palati. 5. Superior constrictor. 6. Levator palati. 7. Stylo-pharyngeus, upper part. 8. Right styloid process. 9. Stylo-hyoid muscle. 10. Stenson's duct. 11. Middle constrictor. 12. Pterygo-maxillary ligament. 13. Internal pterygoid. 14. Buccinator muscle. 15. Stylo-pharyngeus, lower part. 16. Stylo-glossus. 17. Inferior constrictor. 18. Hyo-glossus. 19. Thyro-hyoid membrane. 20. Mylo-hyoid muscle. 21. Thyroid cartilage. 22. Hyoid bone. 23. Crico-thyroid muscle. 24. Trachea. 25. Œsophagus.

The Ascending or Inferior Palatine Artery will be seen to arise from the bend of the facial beneath the jaw (fig. 357, p. 177). It passes upwards in the connective tissue beneath the internal pterygoid to disappear in the palate at the upper border of the superior constrictor. The *tonsillar branch* of the facial also lies beneath the internal pterygoid (fig. 368).

The dissection of the tensor palati, levator palati, Eustachian tube and the contents of the spheno-maxillary fossa is better deferred to a later stage.

DISSECTION XIII

THE SUBPAROTID REGION

Between the deep surface of the parotid gland and the wall of the pharynx there is a small but definite space filled with most important structures, to which, for want of a better, the name of SUBPAROTID SPACE may be given (fig. 368).

The **Boundaries** and **Relations** of this Space are : —

BELOW, it communicates with the superior carotid triangle under the posterior belly of the digastric (figs. 369 and 291, p. 61).

ABOVE, it is bounded by the petro-occipital region of the skull, on which are situated the openings of the carotid and jugular foramina (Plate XLIV, p. 70).

BEHIND, the rectus capitis anticus major and rectus capitis lateralis, in front of the upper two cervical vertebræ, form its posterior wall (figs. 368 and 369).

INTERNALLY, it is bounded by the lateral wall of the pharynx (figs. 368 and 369).

EXTERNALLY, the styloid process, stylo-hyoid and stylo-glossus muscles separate this from the parotid space, which contains the parotid gland (fig. 368, and fig. 357, p. 177).

Contents of the Subparotid Space.

(*a*) The stylo-pharyngeus muscle.

(*b*) The first part of the internal jugular vein.

(*c*) The internal carotid artery.

(*d*) The ascending pharyngeal artery.

(*e*) The subparotid stages of the cranial nerves IX. X. XI. and XII. and their branches.

(*f*) The anterior divisions of the first and second cervical nerves.

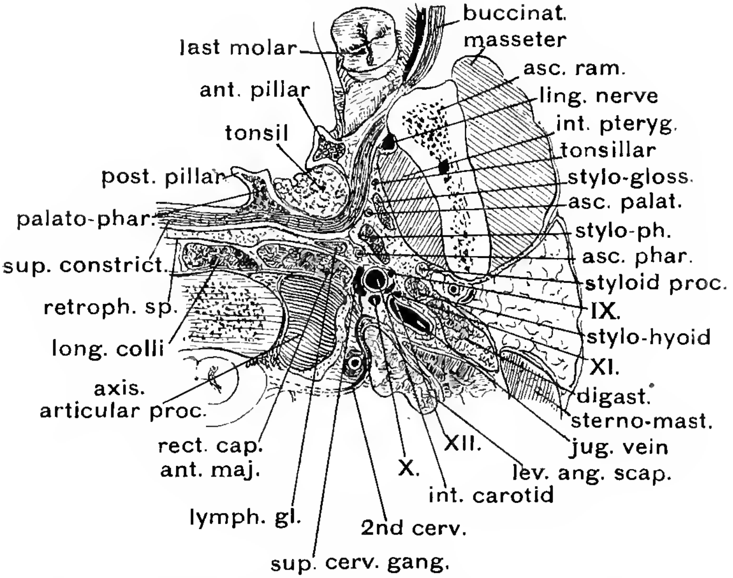
(*g*) The upper half of the superior cervical ganglion.

(*h*) The retro-pharyngeal lymphatic gland.

The subparotid stages of these structures are now to be examined.

The **Stylo-pharyngeus** muscle (fig. 367, 7) arises from the deep aspect of the styloid process near the base. It passes downwards and slightly forwards between the external and internal carotid arteries, and disappears within the pharynx between the upper and middle constrictors (fig. 369). It ends on the posterior border of the thyroid cartilage and over the inner surface of the inferior constrictor, as will be seen at a later stage. As the connective tissue is removed from its outer surface the glosso-pharyngeal nerve should be found (fig. 370). The muscle acts on the pharynx, pulling it upwards to seize the food-bolus as the tongue tilts it from the mouth

FIG. 368.—A SECTION AT THE UPPER BORDER OF THE AXIS TO SHOW THE CONTENTS AND BOUNDARIES OF THE SUBPAROTID SPACE.

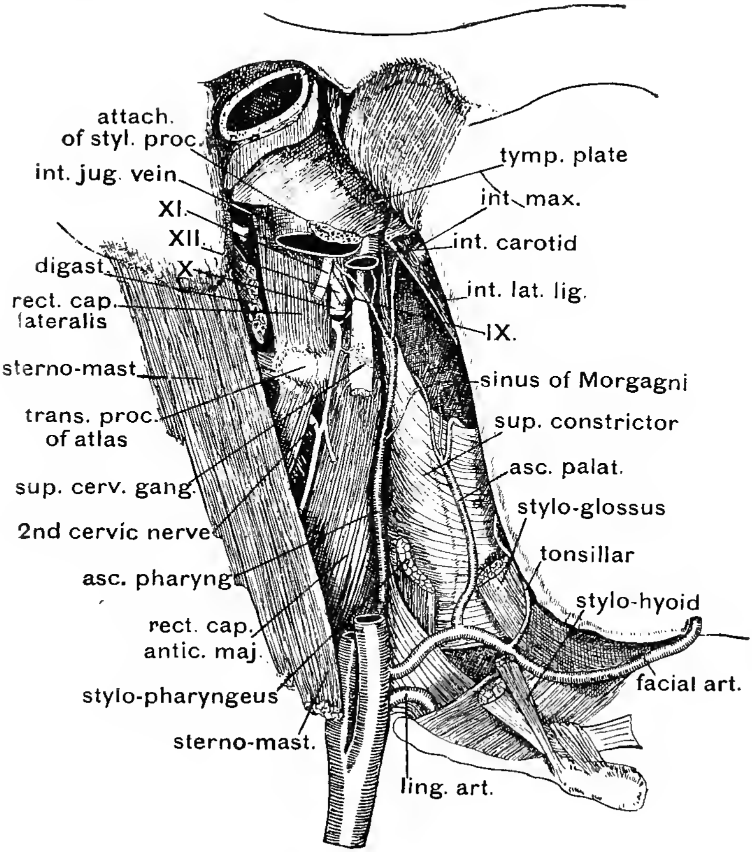


The cranial nerves are indicated by Roman numerals. The position of the following arteries is indicated by abbreviations: Internal carotid, ascending pharyngeal, ascending palatine, and tonsillar. The origin of the anterior division of the second cervical nerve is shown.

The styloid process is to be cut at its base with bone forceps and thrown downwards with its three muscles still attached.

The **Internal Jugular** vein begins by a dilatation in the jugular fossa, where it is continuous with the lateral sinus (fig. 313, p. 115). The tough connective tissue which surrounds the vein and binds all the structures of this space closely together is an upward continuation of the carotid sheath. This connective tissue is attached to the base of the skull above, especially to the lower edge of the vaginal process in front of the carotid foramen. The vein lies behind and to the outer side of the internal carotid artery. Just before the vein passes into the superior carotid triangle beneath the posterior belly of the digastric, the spinal accessory nerve will be seen to cross backwards over (occasionally under) it.

FIG. 369.—THE BOUNDARIES AND CHIEF CONTENTS OF THE SUBPAROTID SPACE.



TRIBUTARIES.—The INFERIOR PETROSAL SINUS will be found joining the vein half an inch below the skull (fig. 314, p. 116).

The upper VEINS OF THE PHARYNGEAL PLEXUS will also be seen to join the internal jugular in this space.

The **Internal Carotid Artery** enters the space beneath the posterior belly of the digastric and passes upwards to enter the carotid canal of the petrous bone, in front of and deep to the internal jugular vein (fig. 368). In this stage it gives off no branch, but is frequently tortuous or thrown into loops in old people, so that it cannot be strained in extension backwards of the head. Its stage within the petrous bone will be seen when the middle ear is dissected (fig. 413, p. 268). The cavernous stage which follows the temporal or petrous stage has already been examined (fig. 317, p. 119).

The **Glosso-Pharyngeal (IX) Nerve** (fig. 370, 2) is best seen by removing the subparotid stage of the internal jugular vein. It enters the roof of the space in a separate dural compartment in the jugular foramen and appears behind the internal carotid artery. It passes downwards for about 1½ inches between the internal carotid and jugular vein; then crosses the artery, hooks round the stylo-pharyngeus, enters the submaxillary space, and disappears on the side of the tongue beneath the insertions of the stylo-glossus and hyoglossus muscles (fig. 370). It supplies sensory fibres to the wall of the pharynx, to the posterior third (pharyngeal part) of the tongue, to the fauces, tonsil and epiglottis. It ends in the taste buds of the circumvallate papillæ, and is the chief nerve of taste. On its trunk, as it lies in the jugular foramen, is a small ganglion (jugular ganglion) and another larger (petrous ganglion) is situated at its point of exit (fig. 370). These cannot be made out now. Communicating twigs join the petrous ganglion to Arnold's nerve and the superior cervical ganglion (fig. 371, 2). A communicating branch passes between it and the facial nerve.

Branches.—(*a*) A TYMPANIC BRANCH (figs. 370 and 371) (Jacobson's Nerve) springs from the petrous ganglion and at once bends forwards to a canal situated on the crest between the carotid and jugular foramina, which should be examined in a skull. Through this foramen the nerve reaches the tympanum, where it will be examined later. Some of the tympanic fibres reach the otic ganglion through the small superficial petrosal nerve (fig. 413, p. 268).

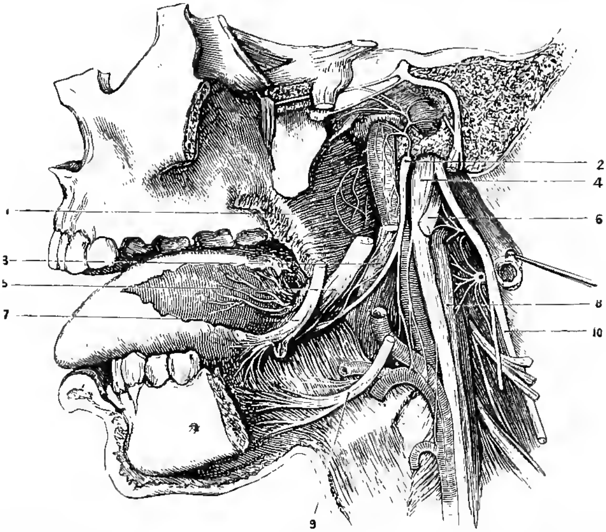
(*b*) *Sensory branches* to join the pharyngeal plexus.

(*c*) *Motor branches* to the stylo-pharyngeus muscle.

(*d*) *Meningeal* branches.

The **Vagus (X) Nerve** passes straight through the subparotid space from the jugular foramen above to the superior carotid triangle below. It lies between and deep to the internal carotid artery and internal jugular vein (figs. 368 and 370). It is bound closely by communicating twigs and fibrous tissue to all the cranial nerves of this space (fig. 371). There are two ganglia imbedded amongst its fibres: one (the GANGLION OF THE ROOT) in the jugular foramen, and a larger one (the GANGLION OF THE TRUNK) below the foramen (fig. 370, 4).

FIG. 370.—THE VESSELS AND NERVES OF THE SUBPAROTID SPACE. (*Hirschfeld and Leveillé.*)



1. Superior constrictor of pharynx. 2. Glosso-pharyngeal nerve. 3. Stylo-pharyngeus. 4. Pneumo-gastric nerve. 5. Stylo-glossus. 6. Hypoglossal nerve communicating with first cervical. 7. Lingual nerve (5th). 8. Superior cervical ganglion. 9. Hypoglossal nerve. 10. Spinal-accessory nerve.

COMMUNICATIONS.—The accessory part of the Eleventh will be seen to join the vagus at the ganglion of the trunk (fig. 371, 18). Twigs communicating with the other cranial nerves of the subparotid space are present; also with the facial nerve and superior cervical ganglion (fig. 371).

Branches.—(*a*) A small MENINGEAL twig to the dura mater from the upper ganglion. It ends in the dura mater of the posterior fossa of the skull.

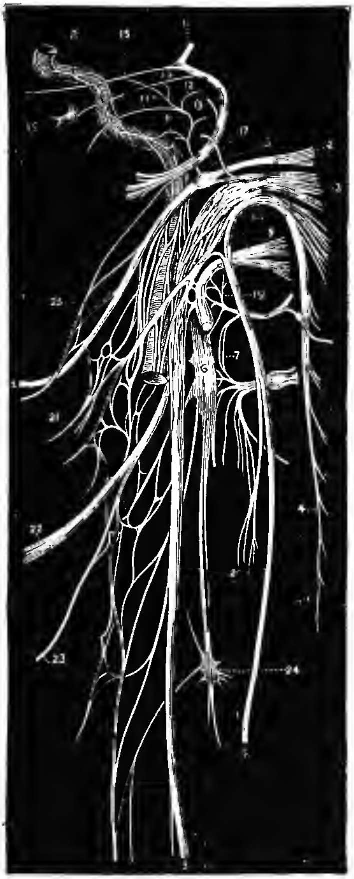
(*b*) The AURICULAR BRANCH (Arnold's Nerve) passes across the jugular foramen from the upper ganglion and emerges behind the ear (fig. 311, p. 107). The nerve is difficult to follow in the osseous part of its course and cannot be seen at present. Its foramen can be detected on the outer side of the jugular foramen in a dried skull. Its distribution in the meatus and ear is described at p. 108.

(*c*) Branches from lower ganglion (ganglion of the trunk) unite in the formation of the PHARYNGEAL PLEXUS (fig. 371, 21). They pass forwards superficial to the internal carotid artery, and convey motor fibres to the walls of the pharynx derived from the accessory part of the Eleventh.

(*d*) The SUPERIOR LARYNGEAL nerve arises from the ganglion of the trunk, and passes obliquely downwards to the larynx on the wall of the pharynx (fig. 292, p. 64). It leaves the subparotid space beneath the internal carotid artery. At this point it gives off its external laryngeal branch to the crico-thyroid muscle and enters the carotid triangle (p. 65).

The **Spinal Accessory Nerve** (XI) perforates the jugular foramen along with the

FIG. 371.—DIAGRAM OF THE NINTH, TENTH, ELEVENTH, TWELFTH CRANIAL, AND SYMPATHETIC NERVES IN THE SUBPAROTID SPACE AND SUPERIOR CAROTID TRIANGLE. (*Hirschfeld and Leveillé.*)



1. Facial nerve. 2. Glosso-pharyngeal nerve, with its petrous ganglion. 3. Pneumogastric nerve. 4. Spinal accessory nerve. 5. Hypoglossal nerve. 6. Superior cervical ganglion of sympathetic. 7. Loop between first and second cervical nerves. 8. Carotid branch of sympathetic. 9. Tympanic nerve (Jacobson). 10. Its branch to carotid plexus. 11. Its branch to Eustachian tube. 12. Its branch to fenestra ovalis. 13. Its branch to fenestra rotunda. 14. Its union with small superficial petrosal nerve. 15. Its union with large superficial petrosal nerve. 16. Otic ganglion. 17. Auricular branch of pneumogastric (Arnold's nerve). 18. Junction of pneumogastric with spinal accessory. 19. Junction of hypoglossal and first cervical nerve. 20. Junction of mastoid branch of spinal accessory and second cervical nerve. 21. Pharyngeal plexus. 22. Superior laryngeal nerve. 23. External laryngeal nerve. 24. Middle cervical ganglion of sympathetic. 25. Junction of digastric nerve (seventh) with glosso-pharyngeal.

vagus (fig. 371, 18). Giving off its accessory part to join the vagus, the nerve passes downwards between the internal carotid artery and internal jugular vein (fig. 370, 10). It appears between these above the level of the posterior belly of the digastric. As a rule it crosses backwards superficial to the vein, but in a small proportion of cases it lies deep to it. The nerve leaves the subparotid space beneath the posterior belly of the digastric and in front of the transverse process of the atlas. It passes beneath the anterior border of the sterno-mastoid an inch below the apex of the mastoid process, where it is looked for when wanted by the surgeon, and sends branches to that muscle, ultimately ending in the trapezius (figs. 291, p. 61; 270, p. 11). The student will be able to observe that, when the face is turned to the opposite side, the transverse process of the atlas moves with the head and carries the trunk of the spinal accessory forwards on it. It is probable that the flash of pain sometimes felt on suddenly turning the head is due to the nerve being caught on the transverse process of the atlas.

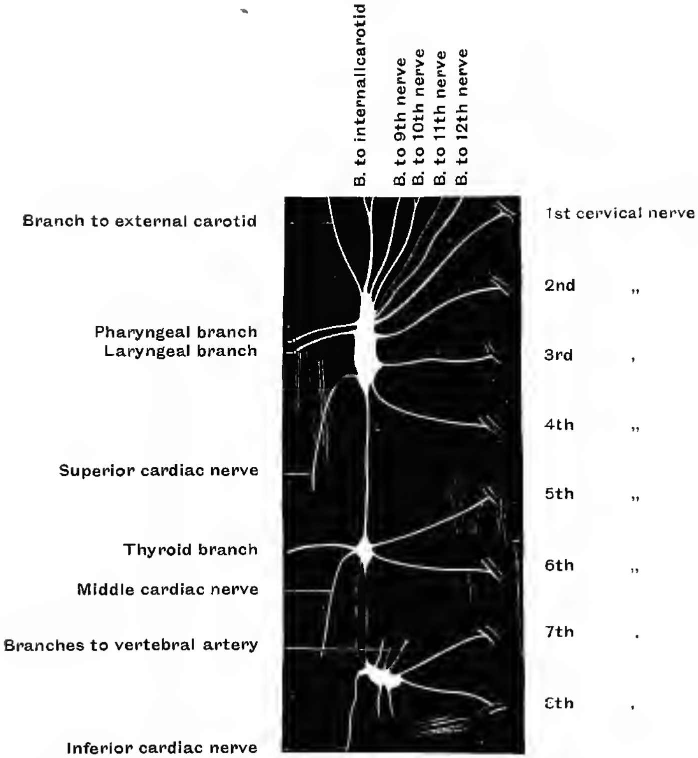
The **Hypoglossal Nerve** (XII).—The hypoglossal nerve leaves the skull by the anterior condylar foramen, and immediately passes downwards and forwards beneath the jugular vein and comes into close contact with the other cranial nerves of this space (fig. 371, 5). It then passes downwards between and deep to the internal carotid artery and jugular vein, and in this position leaves the subparotid space (fig. 291, p. 61). Just below the posterior belly of the digastric, it appears between them and, passing forwards in the superior carotid triangle, crosses the external carotid artery, hooking round its occipital branch (fig. 291). After crossing the superior carotid triangle, it passes within the submaxillary space (fig. 373).

It gives off no branches in the subparotid space, but receives an important contribution from the next nerve.

The ANTERIOR DIVISION OF THE FIRST CERVICAL SPINAL NERVE appears above the transverse process of the atlas and between the rectus capitis anticus minor on its inner and rectus capitis lateralis on its outer side, both of which it supplies (fig. 369). It bends downwards and forms a loop with a branch from the second cervical nerve. From this loop will be seen fibres passing to join the hypoglossal (fig. 371), which, coursing along that nerve, ultimately end in the infra-hyoid group of muscles by the descendens hypoglossi and in the thyro-hyoid muscle.

Superior Cervical Ganglion.—Every day the physiological and clinical importance of this ganglion is becoming more evident. It rests on the rectus capitis anticus major and rectus capitis lateralis, in front of the transverse processes of the 1st, 2nd, and 3rd cervical vertebræ (fig. 369). It will be thus seen that only the upper half of the ganglion, which is fusiform in shape and considerably over an inch in length, lies in the sub-parotid space. The great vessels and nerves of the space lie in front of it, and have to be lifted forwards to expose it (fig. 368). The surgeon may reach it under the posterior border of the sterno-mastoid and seize it whilst passing into the superior carotid triangle, behind the great vessels.

FIG. 372.—DIAGRAM OF THE SUPERIOR CERVICAL GANGLION AND ITS CONNECTIONS. (*Heath.*)



It forms COMMUNICATIONS with every one of the four cranial nerves in the space (fig. 372) and it is connected by grey rami communicantes with the cervical nerves from the 1st to the 4th. The sympathetic cord joins its lower pole and brings fibres from the spinal centres which escape from the spinal cord by the upper dorsal rami communicantes. From its upper pole a great stream of fibres joins the internal carotid artery to form the carotid and cavernous plexuses (fig. 369, p. 196). Through the cavernous plexus it supplies the dilator fibres of the iris, the non-striated muscles of the orbit, and sends sympathetic twigs to the IIIrd, IVth, Vth, and VIth cranial nerves. From the carotid plexus it gives off fibres to the spheno-palatine (Meckel's) and otic ganglia through the petrosal nerves (fig. 413, p. 268). From the superior cervical ganglion fibres stream to the external carotid artery, and on the coats of the branches reach the parts supplied by the artery. It thus supplies the vaso-motor nerves of the face, tongue, and thyroid gland. With branches from the vagus and glosso-pharyngeal, it forms the PHARYNGEAL PLEXUS, thus supplying the pharynx with vaso-motor nerves. The superior cardiac branch springs from it and forms communications with the superior laryngeal nerve (fig. 292, p. 64). Altogether the superior cervical ganglion merits more attention than it usually receives. It is closely connected with the inter-carotid body situated on the inner aspect of the bifurcation of the common carotid.

The ASCENDING PHARYNGEAL ARTERY (fig. 369) arises from the inner aspect of the external carotid in the upper part of the superior carotid triangle. The artery passes up in the subparotid space, deep to the great vessels and nerves, and supplies the wall of the pharynx as it ascends. Its terminal branches enter the skull by the anterior condylar and jugular foramina and foramen lacerum medium, and end in the dura mater and nerve sheaths. One little branch, the *tympanic*, enters the tympanum with the nerve from the glosso-pharyngeal. Other branches end in the prevertebral muscles and form a close anastomosis with the vertebral, deep cervical, and ascending cervical arteries.

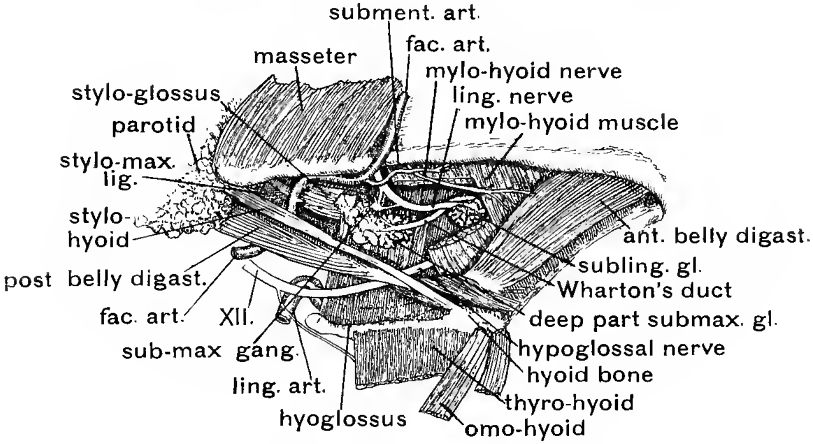
The RETRO-PHARYNGEAL LYMPH GLAND lies below the jugular foramen, behind the pharynx, and in front of the rectus capitis anticus major (fig. 368). It receives lymphatic vessels from the cranial cavity and from the pharynx, and enlarges in diseases of these cavities. The loose retro-pharyngeal tissue in which it lies gives free scope for the formation of abscesses.

DISSECTION XIV

THE SUBMAXILLARY TRIANGLE AND SPACE

The Triangle. BOUNDARIES (fig. 373).—The lower border of the mandible bounds the triangle above; the anterior belly of the digastric, which can be seen and felt in life, bounds it below and in front; behind and below, the stylo-maxillary ligament and part of the posterior belly of the digastric form its boundary. The apex of the triangle is below, where the intermediate tendon of the digastric is bound to the hyoid bone near the lesser horn. This point can always be distinguished by the finger, and from it the two lower boundaries of the triangle may be mapped out on the surface of the neck. It is usual to describe the submaxillary or digastric triangle as being continued backwards to the mastoid process, the whole of the posterior belly of the digastric being included in the lower and posterior border, while a line continuing back the border of the jaw to the mastoid completes the upper boundary. A part of the parotid gland and space is thus included in the triangle. The boundaries given above are more natural and of greater practical utility.

FIG. 373.—THE BOUNDARIES AND FLOOR OF THE SUBMAXILLARY SPACE.



Structures covering the Triangle.—Of the structures which help to form the roof of the submaxillary triangle, the skin and platysma have both been described. The cervical branches of the facial, of the great auricular and superficial cervical nerves, which supply the platysma and skin of this region, have also been examined (fig. 270, p. 11).

The *deep cervical fascia*, which covers the triangle and is attached to the lower border of the mandible, sends off a deep layer at the lower limit of the triangle. When the fascia is detached from the lower jaw and reflected downwards, the deeper layer will be seen passing upwards under the submaxillary gland to the deep surface of the jaw. These two layers form a compartment for the gland and bind it to the lower jaw.

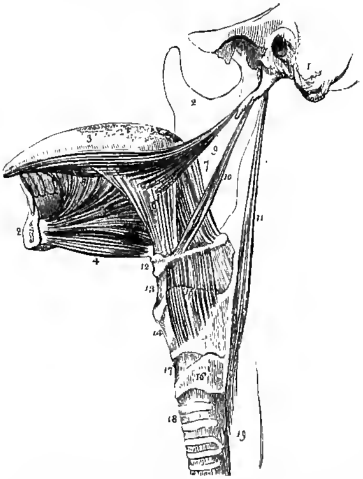
The **Digastric Muscle** (fig. 373) forms the lower limits of the triangle. The anterior belly lies on the mylo-hyoid muscle, and is inserted to an oval impression on the lower border of the symphysial part of the lower jaw (Plate LII, p. 180). The intermediate tendon, which joins it to the posterior belly, is bound by a sheath of fibrous tissue to the body of the hyoid in front of the lesser horn. The posterior belly arises from the digastric fossa (Plate XLIV, p. 14) beneath the mastoid process, and runs under the angle of the jaw to join the intermediate tendon. As it passes the angle of the jaw, the stylo-maxillary ligament adheres to its sheath; behind that point it separates the superior carotid triangle from the parotid space (fig. 291, p. 61); in front of the angle it separates the carotid triangle from the submaxillary triangle and space. The anterior belly is supplied by the mylo-hyoid (fig. 373), the posterior belly by the facial nerve (fig. 357).

The action of the digastric muscle is complicated, and should be studied now. If the mandible is fixed by the muscles of mastication, as during the act of swallowing, both bellies raise the hyoid bone and floor of the mouth, the tongue being pressed against the palate. The posterior belly pulls the hyoid and tongue upwards and backwards. If the hyoid bone is fixed by its depressor muscles, both bellies act together and depress the jaw.

The **Stylo-hyoid Muscle** (fig. 374) was seen to arise in the parotid space from the posterior aspect of the styloid process near its base. Leaving the parotid space, it splits to enclose the tendon of the digastric and is inserted to the outer aspect of the hyoid, near the lesser horn, and thus helps to bound the submaxillary space behind (fig. 373). It is supplied by a branch from the facial nerve which is given off near the stylo-mastoid foramen. Through the hyoid bone it raises the tongue upwards and backwards against the palate.

Boundaries of the Submaxillary Space.—The three sides of the submaxillary triangle form the superficial limits of the submaxillary space. Its *floor* is formed by the muscles of the tongue—chiefly by the *hyo-glossus* (fig. 373). Its outer wall or roof includes not only the coverings of the submaxillary triangle, skin, superficial fascia, platysma, and deep fascia, but also that part of the mandible which lies below the level of the floor of the mouth. *Above*, only the mucous membrane between the side of the tongue and the gum separates it from the cavity of the mouth. It is continued in front into the sublingual space which contains the sublingual gland (fig. 378). The submaxillary is a space of surgical importance, especially as regards operations for the complete extirpation of cancer of the tongue.

FIG. 374.—STYLOID MUSCLES AND MUSCLES OF THE TONGUE. (*Wilson.*)



1. Temporal bone of the left side. 2, 2. The right side of the lower jaw, divided at its symphysis, the left side having been removed. 3. Tongue. 4. Genio-hyoid. 5. Genio-hyo-glossus. 6. Hyo-glossus; its chondro-glossus portion. 7. Its hyo-glossus portion. 8. Anterior part of the inferior lingualis issuing from between the hyo-glossus and genio-hyo-glossus. 9. Stylo-glossus with part of the stylo-maxillary ligament. 10. Stylo-hyoid. 11. Stylo-pharyngeus. 12. Os hyoides. 13. Thyro-hyoid membrane. 14. Thyroid cartilage. 15. Thyro-hyoid muscle arising from the oblique line of the thyroid cartilage. 16. Cricoid cartilage. 17. Crico-thyroid membrane, through which the operation of laryngotomy is performed. 18. Trachea. 19. Commencement of the œsophagus.

Contents of the Submaxillary Space (fig. 373).

(*a*) The submaxillary gland and duct.

(*b*) Submaxillary stage of the facial artery and vein, with the branches and tributaries given off from it.

(*c*) Lingual nerve.

(*d*) Hypoglossal nerve.

(*e*) Submaxillary ganglion.

(*f*) Submaxillary lymphatic glands.
(*g*) Mylo-hyoid nerve and artery.
(*h*) Part of the mylo-hyoid muscle.
(*i*) The lingual vein.

These structures are now to be examined.

Mylo-hyoid Muscle (figs. 373 and 378).—The part of the mylo-hyoid which projects within the submaxillary triangle, usually described as part of the floor of the triangle, divides the submaxillary space in front into a deep and a superficial compartment. The muscle forms a contractile diaphragm in the buccal floor, and arises above from the mylo-hyoid ridge on the inner aspect of the mandible (fig. 377). Its origin extends from below the last molar tooth to near the symphysis (Plate LII, p. 180). The anterior fibres meet with those from the opposite side in a median fibrous raphe between the symphysis of the jaw and body of the hyoid; the posterior fibres pass obliquely to their insertion on the upper and anterior aspect of the body of the hyoid. The muscle is supplied by the mylo-hyoid nerve, a branch of the inferior dental (fig. 373). If the hyoid bone is fixed, it lowers the jaw, but it usually acts from the jaw, elevating the hyoid, the tongue, and rendering tense the whole floor of the mouth, an action required in chewing, swallowing, and speaking.

The MYLO-HYOID NERVE AND ARTERY will be found passing forwards on the mylo-hyoid muscle under cover of the jaw (fig. 373). They are branches of the inferior dental nerve and artery (fig. 365, p. 189), and supply the mylo-hyoid and anterior belly of the digastric.

The **Submaxillary Gland** is subdivided by the posterior border of the mylo-hyoid muscle into a large superficial and a small deep part. The superficial part commonly extends beyond the limits of the submaxillary triangle, and lies partly in the superior carotid triangle. The dissector has already seen how the deep cervical fascia divides to encapsulate and bind it to the jaw. The facial vein crosses it superficially, while the artery lies deep to it (fig. 307). When the superficial part is raised with the handle of the scalpel, branches from the vessels will be seen to enter the gland. When the superficial part is dislodged and drawn downwards and backwards, the deep part comes into view as it passes under the mylo-hyoid muscle. From the deep part, the submaxillary duct (Wharton's Duct) will be found running forwards (fig. 373). The deep part of the gland rests on the hyo-glossus muscle—the floor of the submaxillary space.

The SUBMAXILLARY or WHARTON'S DUCT and the deep part of the gland can now be displayed by detaching and throwing down the origin of the posterior part of the mylo-hyoid muscle from the jaw, so that it falls over the anterior belly of the digastric (fig. 373). To expose the space, so as to examine its contents with greater ease, a section should be made across the jaw with a saw, behind the insertion of the anterior belly of the digastric. The posterior part of the jaw may then be turned upwards and fixed. The superficial part of the gland should be cut away. The duct will be seen to lie first on the hyo-glossus muscle, then to pass upwards and forwards in the sublingual space to open on the sublingual papilla (fig. 378). The sublingual part of its course will be better seen in the dissection of that space. Passing forwards above the deep part of the gland is the lingual nerve (fig. 373). In the fibrous tissue which unites the nerve and gland is placed the submaxillary ganglion (fig. 373).

The SUBMAXILLARY LYMPHATIC GLANDS have already been seen (fig. 307, p. 102) grouped around the facial artery as it escapes between the jaw and gland. They are also imbedded in the substance of the gland. Besides the lymphatics of the face, those from the side of the tongue and buccal floor end in them, and hence the necessity of removing the submaxillary lymphatic glands in complete extirpation of lingual or labial cancer.

SUBMAXILLARY STAGE OF THE FACIAL VEIN.—The vein leaves the space and unites in the upper part of the superior carotid triangle with the anterior division of the temporo-maxillary vein (fig. 367, p. 193). It terminates in the internal jugular vein, some distance below the posterior belly of the digastric. The facial vein receives tributaries from the submaxillary space and passes over the superficial aspect of the gland.

Submaxillary Stage of the Facial Artery (see figs. 369 and 373).—After a short stage in the superior carotid triangle, where it arises from the external carotid, the facial artery enters the submaxillary space beneath the posterior belly of the digastric. It lies beneath the submaxillary gland and rests on the middle constrictor, stylo-glossus, and hyo-glossus muscles, and before emerging between the lower border of the jaw and the gland makes a deep bend beneath the angle of the jaw, where it approaches the outer aspect of the tonsil (see fig. 369). The bend on the artery allows it to remain unstretched when the jaw is depressed.

Branches.—In its submaxillary stage the artery gives off the following branches:

(*a*) The ASCENDING or INFERIOR PALATINE, which passes upwards beneath the internal pterygoid muscle to the palate (p. 193 and fig. 369).

(*b*) The TONSILLAR, which ascends to the tonsil (fig. 369).

(*c*) GLANDULAR BRANCHES to the submaxillary gland (fig. 373).

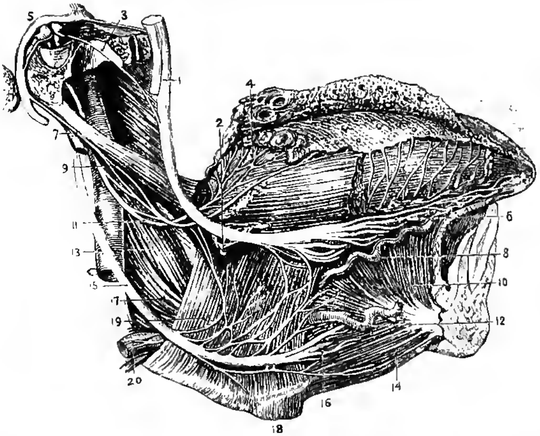
(*d*) The SUBMENTAL, a branch which passes forwards beneath the gland and the jaw and rests on the mylo-hyoid muscle (fig. 373). It ends in the structures on and under the chin, forming anastomoses with the sublingual and other surrounding arteries.

The SUBMAXILLARY GANGLION lies in the connective tissue between the commencement of the submaxillary duct and the lingual nerve (fig. 373). It is most easily found by pulling the deep part of the submaxillary gland and duct downwards, and thus stretching the connective tissue in which the ganglion lies. The roots which join it to the lingual nerve contain secretory fibres derived from the chorda tympani and sensory fibres from the lingual. Sympathetic fibres reach it round branches of the facial artery. Its issuing twigs go to the submaxillary gland; others, passing forwards, reach the sublingual gland, and some again join the lingual nerve.

The **Lingual Nerve**, in its submaxillary stage, crosses the hyoglossus beneath the mucous membrane at the side of the tongue (fig. 376). Its zygomatic stage has already been seen (fig. 358, p. 181). As it crosses the hyo-glossus muscle it lies at first above the submaxillary gland and duct (fig. 373), but as it passes forwards to the sublingual space it proceeds under and hooks round the duct. It pierces the substance of the tongue to end in the mucous membrane of its anterior two-thirds (buccal part), and also in the mucous membrane on the floor of the mouth and gums (fig. 375). It is a sensory nerve, its taste fibres being probably derived from the chorda tympani. On the hyoglossus muscle it sends a communication to the hypoglossal nerve (fig. 375).

Hypoglossal Nerve.—The first two stages of this nerve have been seen in the subparotid space (p. 200) and superior carotid triangle (fig. 375). It enters its third (submaxillary) stage beneath the posterior belly of the digastric, and crosses the hyoglossus muscle above the great horn of the hyoid (fig. 373). It then enters the sublingual space and disappears in the musculature of the tongue (fig. 378). It is the motor nerve of all the intrinsic and nearly all the extrinsic muscles of the tongue. The depressors of the hyoid bone, and therefore of the tongue, are supplied by fibres which accompany the nerve (descendens hypoglossi and nerve to thyro-hyoid). It supplies the hyoglossus, the stylo-glossus and palato-glossus, genio-hyoid and genio-glossus, and the intrinsic muscles of the tongue.

Fig. 375.—The nerves of the tongue and submaxillary space. (*Hirschfeld and Leveillé.*)



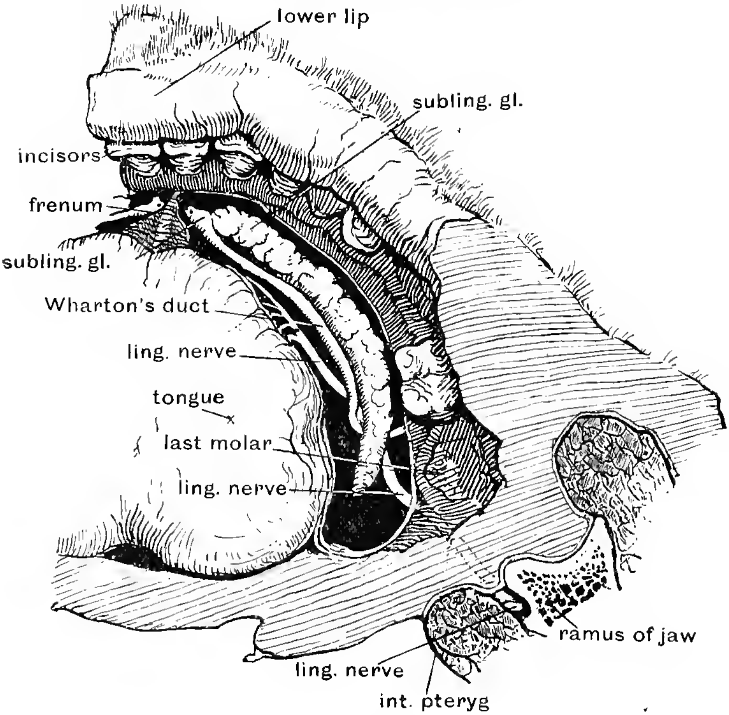
1. Lingual nerve (5th). 2. Submaxillary ganglion. 3. Chorda tympani nerve. 4. Distribution of glosso-pharyngeal nerve to circumvallate papillæ. 5. Facial nerve (7th). 6. Distribution of lingual nerve (5th). 7. Communication between facial and glosso-pharyngeal nerve. 8. Ranine artery. 9. Stylo-glossus. 10. Genio-glossus. 11. Glosso-pharyngeal nerve. 12. Sublingual artery. 13. Stylo-pharyngeus. 14. Genio-hyoideus. 15. Hypoglossal nerve (12th). 16. Distribution of twelfth nerve. 17. Middle constrictor of pharynx. 18. Hyoid bone. 19. Hyoglossus. 20. Lingual artery.

The Lingual Vein arises by tributaries from the tongue (ranine vein) and sublingual space, and passes backwards on the hyoglossus muscle above the hypoglossal nerve. It joins the internal jugular in the upper part of the superior carotid triangle (fig. 291, p. 61).

Floor of the Submaxillary Space.—The hyoglossus muscle, which enters the lateral part of the tongue in this region, forms the greater part of the floor of the submaxillary space (fig. 373). A slight part behind is formed by the insertion of the stylo-glossus and the middle constrictor of the pharynx. The hyoglossus, and all the structures which lie deep to it, must be regarded as intrinsic parts of the tongue, and therefore should be dissected along with that organ.

The Pterygo-maxillary Ligament (fig. 367, 12, p. 193) should be examined before cutting away the upturned piece of the lower jaw which covered the submaxillary space, and on which the impression of the submaxillary gland can be seen (Plate LII, p. 180). The pterygo-maxillary ligament is an indistinct fibrous raphe lying between the origins of the buccinator in front and the superior constrictor behind. It is attached above to the internal pterygoid plate at the hamulus, and below to the posterior end of the mylo-hyoid ridge of the mandible.

Fig. 376.—Structures beneath the mucous membrane of the floor of the mouth. (*Alfred Billinghurst.*)



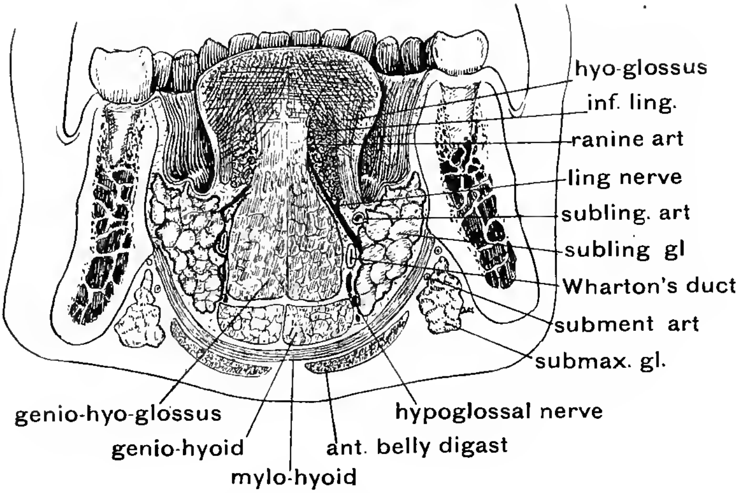
The attachment to the inner aspect of the mandible of this ligament, superior constrictor, and buccal mucous membrane should be cut away and the detached part of the mandible removed and kept for the examination of the teeth. Both bellies of the digastric and the stylo-hyoid muscle should also be cut completely away, before proceeding to the dissection of the sublingual space.

DISSECTION XV

THE SUBLINGUAL SPACE

The **Sublingual Space** (figs. 377 and 378) is covered *above* by the mucous membrane in the floor of the mouth, between the tongue and that part of the mandible which carries the incisor, canine, and bicuspid teeth; its *outer wall* or floor is formed by the anterior part of the mylo-hyoid muscle; its *inner wall* will be seen to be formed by the genio-glossus and genio-hyoid muscles, until they disappear beneath the hyoglossus muscle (fig. 377). Behind, it is continuous with the submaxillary space between the anterior border of the hyoglossus and the overlying mylo-hyoid muscle (fig. 378).

FIG. 377.—SECTION OF THE FLOOR OF THE MOUTH AND TONGUE TO SHOW THE CONTENTS OF THE SUBLINGUAL SPACE.



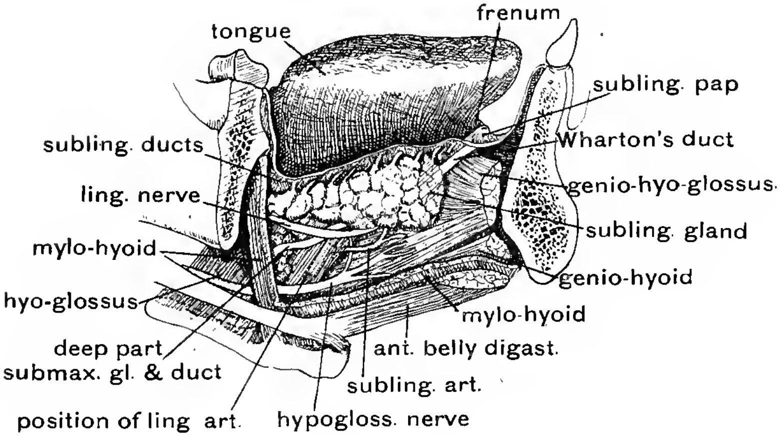
Through this opening the submaxillary duct, the lingual and hypoglossal nerves, and the lingual vein pass from the submaxillary to the sublingual space.

Contents of the Sublingual Space (fig. 378) :

(*a*) Sublingual Gland ;
(*b*) Submaxillary Duct ;
(*c*) Lingual Nerve ;
(*d*) Hypoglossal Nerve ;
(*e*) Sublingual Vessels ;
(*f*) Lingual Vein.

The SUBMAXILLARY (WHARTON'S) DUCT passes forwards beneath the buccal mucous membrane, which covers the space, and along the inner side of the sublingual gland (fig. 376). As the student dissects off the mucous membrane of the gland and follows the duct to its opening on the sublingual papilla at the side of the frenum of the tongue, he will notice how loose the connective tissue is that surrounds it, and how easily the duct could be exposed in the floor of the mouth between the tongue and gum (fig. 376). As it enters this space the lingual nerve hooks round it.

FIG. 378.—THE CONTENTS OF THE SUBLINGUAL SPACE.



The **Sublingual Gland,** made up of a series of lobules, almost fills the sublingual space, its posterior attenuated extremity extending backwards on the hyoglossus muscle, into the submaxillary space (fig. 378). The gland raises the mucous membrane over it into a ridge, which ends in front at the sublingual papilla. The sublingual or ducts of Rivinus open along the ridge. The most anterior of these ducts is larger and longer than the others (Bartholin's duct). To the inner side of the gland lies the submaxillary duct (fig. 376) ; on the outer side, the gland lies against the mylo-hyoid and inner surface of the jaw, on which it leaves a smooth oval impress (fig. 377). The anterior ends of the two glands are almost in contact beneath the frenum linguæ.

The SUBLINGUAL ARTERY springs from the lingual as that vessel turns up under the anterior border of the hyoglossus (fig. 378). It supplies the gland and the structures in the floor of the mouth behind the symphysis. It anastomoses with the submental and other surrounding vessels. The sublingual vein joins the lingual. The lymphatics of the space end in the submaxillary group of glands and in the upper deep cervical group.

The terminal parts of the HYPOGLOSSAL and LINGUAL nerves have been seen to enter the space and end in the tongue (fig. 375). The LINGUAL ARTERY turns upwards into the tongue beneath the hyoglossus muscle, and as a rule only a small part of it is seen within the space as above defined (fig. 375).

The mylo-hyoid muscle should now be cut completely away.

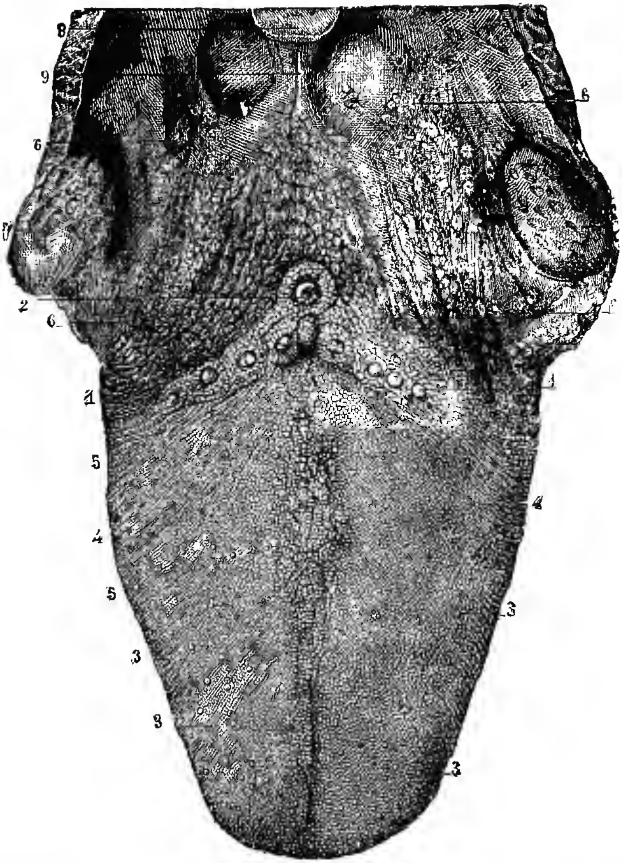
DISSECTION XVI

THE TONGUE

Although the tongue cannot be completely dissected at the present stage, it is better to examine its principal parts now, so that they may be studied *in situ* and in their proper relationships to neighbouring parts. The dissection of the submaxillary and sublingual spaces has displayed the lingual structures on their lateral aspects.

Divisions of the Tongue.—Before the dissection of the tongue is proceeded with, it is better to form a clear conception of its relationship to the buccal and pharyngeal cavities by the examination of a median vertical section, such as is shown in Plate LIII (p. 244). It will then be seen that the mucous surface of the tongue is divided into two distinct divisions, different in function, in structure, and in origin. The anterior two-thirds of the tongue—the BUCCAL DIVISION—lies within the mouth, is directed upwards against the palate, is concerned in

FIG. 379.—THE DORSAL ASPECT OF THE TONGUE. (*Hirschfeld and Leveillé.*)

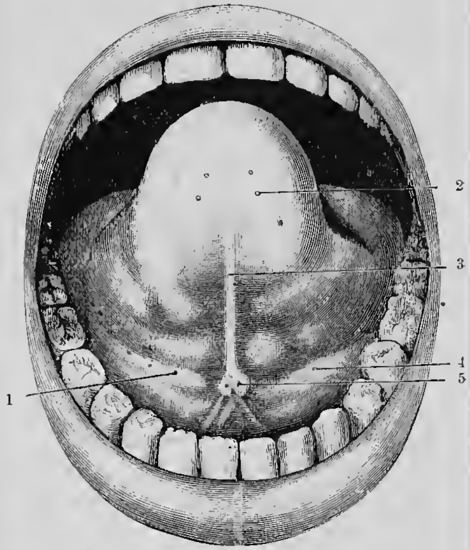


1. Circumvallate papillæ. 2. Foramen cæcum. 3, 3, 3, 3. Fungiform papillæ. 4, 4. Filiform papillæ. 5, 5. Lateral rows of filiform papillæ. 6, 6, 6, 6. Glands at the base of the tongue. 7. Tonsil. 8. Epiglottis. 9. Middle glosso-epiglottic fold.

mastication, covered by filiform and fungiform papillæ, and terminates at the brink of the pharynx in a V-shaped furrow fringed anteriorly by circumvallate or taste papillæ (fig. 379, 1). The posterior third—the PHARYNGEAL DIVISION—is directed backwards, forms part of the anterior wall of the pharynx, is covered by a mucous membrane thickly planted with mucous glands and lymphoid tissue, and is concerned in swallowing. As the food passes over the circumvallate papillæ from the buccal to the pharyngeal part of the tongue, it passes also from the region of voluntary to the region of involuntary action. Of the extrinsic muscles of the tongue only the genio-glossus sends terminal fibres to the pharyngeal division.

The Frenum Linguæ (fig. 380, 3) is a median fold of the mucous membrane on the floor of the mouth, continued to the under surface of the tongue. On each side of it are situated the sublingual papillæ (fig. 380, 5). It can limit the movements of the tongue to only a limited degree. The lingual vessels pass upwards on the under surface of the tongue, at each side of the lingual attachment of the frenum.

Fig. 380.—The under surface of the tongue (*Modified from Merkel.*)



1. Ducts of Rivinus. 2. Ducts of Nuhn or Blandin (line crosses fimbriated fold or plica fimbriata). 3. Frænum. 4. Sublingual ridge. 5. Ducts of Wharton, opening on sublingual papillæ.

Subapical Mucous Glands.—Beneath the tip of the tongue, situated under the mucous membrane and a layer of muscle, will be found on each side a small group of mucous glands (Glands of Nuhn) (fig. 380, 2). Similar glands are found beneath the mucous membrane on the lower side of the tongue (fig. 382, 8), and also under the mucous membrane of the floor of the mouth behind the symphysis. These glands may become cystic. Their secretion lubricates the mouth. On each side of the under surface of the tongue, situated parallel to and some distance from the frenum, are commonly to be found two slight folds of mucous membrane—the PLICÆ FIMBRIATÆ (fig. 380). They lie over the ranine vessels.

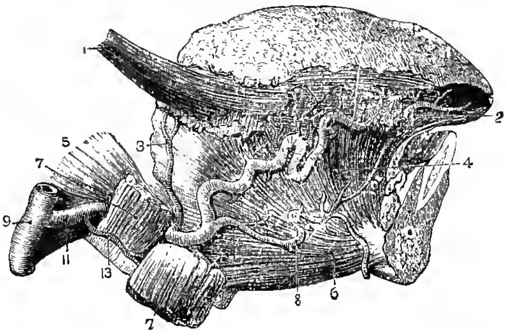
Genio-hyoid Muscle (fig. 378).—To see its origin, a vertical section of the jaw should be made in the line of the lateral incisor tooth. If possible the section should pass through the tooth, so as to display its structure and the manner in which it is fixed within its socket. The mandible at this point is very dense, and the symphysis should be held in a strong pair of bone forceps while the section is being made.

The muscle will be seen to take its *origin* from the posterior surface of the symphysis, near the lower border, the point of origin being marked by the inferior genial tubercle (Plate LII, p. 180). It passes backwards to *end* on the upper and anterior surface of the body of the hyoid. If the hyoid is fixed by the sternal muscles, the genio-hyoid, when it acts, depresses the jaw ; if the jaw is fixed, then the muscle pulls the hyoid towards the symphysis, moving the tongue forwards at the same time. It is supplied by the hypoglossal nerve (fig. 375).

The **Hyoglossus Muscle** (fig. 375, 19) is crossed obliquely by the posterior belly of the digastric, so that while its anterior and upper part forms the floor of the submaxillary space, its hinder and lower part lies in the superior carotid triangle (fig. 373, p. 203). It *arises* from the upper border of the great horn of the hyoid in its entire length, and also from part of the body of the hyoid bone. A special slip arises from the small horn of the hyoid (chondro-glossus, fig. 374). The muscle, a flat quadrate sheet, passes upwards and forwards *to end* in the side of the tongue, under the insertion of the stylo-glossus and palato-glossus muscles (fig. 381). When it *contracts*, the great horn being fixed by the thyro-hyoid, the muscle will depress and slightly retract the tongue. The extent of its action may be increased by a simultaneous contraction of the thyro-hyoid. It is a muscle much used in singing and speaking. If the tongue is fixed by the stylo-glossus and palato-glossus, the muscle may elevate the hyoid and larynx. It is supplied by the hypoglossal nerve. The structures which pass forwards on the hyoglossus—the lingual nerve, submaxillary duct, lingual vein, and hypoglossal nerve (fig. 378)—should be cut through at its posterior border and thrown forwards.

Lingual Artery.—The origin of the lingual artery from the external carotid was seen to take place in the superior carotid triangle, just behind the great horn of the hyoid (fig. 369, p. 196). The great horn can always be felt in the neck ; it is the best guide to the lingual artery, which forms a loop (the cornual loop) round its posterior extremity and passes forwards immediately above it. The cornual loop of the artery is to allow for the movements of the great horn and tongue. There are three distinct stages in the course of the lingual artery, in any one of which it may be necessary for the surgeon to expose the artery. Its first stage—the *carotid stage*—lies in the upper part of the superior carotid triangle (fig. 369, p. 196); its second—the *deep stage*—lies beneath the hyoglossus and floor of the submaxillary space (fig. 375, p. 209); the third or *superficial* stage, where the artery takes the name of ranine, lies along the under surface of the free tongue (fig. 381).

Fig. 381.—The course and branches of the lingual artery. *Hirschfeld and Leveillé.)*



1. Stylo-glossus muscle. 2. Ranine artery. 3. Dorsalis linguæ artery. 4. Genio-hyo-glossus muscle. 5. Middle constrictor. 6. Genio-hyoid muscle. 7, 7. Hyo-glossus (cut). 8. Sublingual artery. 9. External carotid artery. 11. Lingual artery. 13. Hyoid branch.

The First or Carotid Stage (fig. 369, p. 196) rests on the middle constrictor of the pharynx. The hypoglossal nerve passes over the cornual loop of the artery, while the lingual vein passes backwards on its outer surface. At first it is superficial, being covered only by skin, superficial fascia, platysma, and deep cervical fascia; but as it passes forwards, above the great horn, it goes under the hyoglossus. It is in this stage that the artery is usually tied (fig. 373, p. 203).

The Second or Deep Stage lies beneath the floor of the submaxillary space, and the contents of that space (fig. 375). It rests on the stylo-hyoid ligament as it leaves the carotid triangle. Passing at first forwards, it then bends upwards beneath the hyoglossus muscle. The hypoglossal nerve, separated from it by the hyoglossus, crosses the upward bend of the artery. Deep to the artery in this stage is the genio-glossus muscle (fig. 381).

The Third or Superficial Stage (fig. 381). The ranine artery continues the lingual forwards along the under surface of the tongue. In life, when the under surface of the tongue is examined, the position of the ranine artery and its accompanying veins can be distinguished under the mucous membrane. As soon as the artery emerges from the cover of the hyoglossus, it disappears between the genio-glossus and the inferior longitudinal lingual muscles (fig. 382, 9). The terminal twigs of the lingual and hypoglossal nerves lie both superficial and deep to the artery.

Branches of the Lingual Artery.—From the *first stage* arise:

The Supra-hyoid branch, which passes forwards on the muscles attached to the great horn.

From the *second stage*:

(*a*) The Tonsillar Artery, which passes up beneath the hyoglossus muscle to the tonsil, fauces, and surrounding tissue. It frequently arises from the next branch.

(*b*) The Dorsalis Linguæ, a branch of some size, proceeds upwards beneath the hyoglossus to the structures in the posterior part of the tongue (fig. 381, 3).

(*c*) The Sublingual Artery ends in the structures of the sublingual space (fig. 381, 8).

From the *third stage*:

Numerous branches pass upwards from the ranine and supply the great capillary network beneath the mucous membrane of the tongue (fig. 381). There is only a slight degree of anastomosis across the septum of the tongue between the two lingual arteries.

Structures beneath the Hyoglossus.—When the structures superficial to the hyoglossus are cut away, and the muscle reflected upwards and all but its terminal insertion to the tongue cut away, the following structures should be sought for:

(*a*) The Lingual Artery, with small venæ comites (fig. 381).

(*b*) The Stylo-hyoid Ligament, passing from the tip of the styloid process to the lesser horn (fig. 374). It is sometimes ossified.

(*c*) The Terminal stage of the glosso-pharyngeal nerve, (fig. 370, p. 198).

(*d*) The INFERIOR LINGUALIS MUSCLE, one of the intrinsic muscles of the tongue (fig. 382). It runs forwards in the tongue on the genio-glossus. It unites in front with the forward continuation of the stylo-glossus, which is superficial to the insertion of the hyoglossus.

(*e*) The **Genio-glossus (Genio-hyo-glossus) Muscle** which forms the great muscular substratum of the tongue (figs. 377 and 378). It takes origin on the posterior aspect of the symphysis, above the origin of the genio-hyoid, at a point marked by the upper genial tubercle or spine (Plate LII, p. 180). The fibres radiate into the buccal and pharyngeal divisions of the tongue, its fibres terminating in the fibrous tissue beneath the mucous membrane and in the intrinsic muscles.

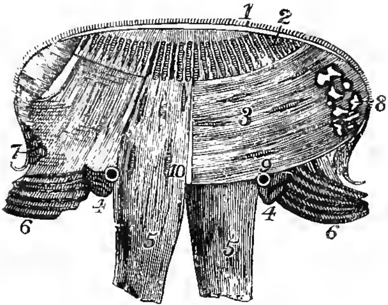
A few of the lower fibres may have a direct attachment to the hyoid bone; others end in a fibrous band attached to the epiglottis (see fig. 390). When the origin of this muscle is detached during life the tongue and consequently the epiglottis fall backwards within the pharynx and may cause suffocation; in deep chloroform anæsthesia, the same effect is partly produced by paralysis of the muscle. When the whole muscle contracts, the tongue is drawn forwards behind the lower incisor teeth; when the pharyngeal part contracts alone, the tongue is drawn forwards and protruded; when the buccal part acts by itself, the tongue is depressed and retracted. The terminal branches of the hypoglossal nerve end in it.

The STYLO-GLOSSUS MUSCLE arises from the styloid process in the parotid space and passes forwards beneath the internal pterygoid muscle and angle of the jaw to terminate along the side of the tongue, superficial to the insertion of the hyoglossus (figs. 374 and 381). It is supplied by the hypoglossal nerve. When it contracts it pulls the tongue upwards and backwards, a movement executed in pushing a bolus of food through the fauces from the buccal to the pharyngeal cavity.

The PALATO-GLOSSUS.—Its origin from the under surface of the soft palate cannot be examined at the present stage, but the thin band of fibres, of which it is composed, may be seen as it descends in the anterior pillar of the fauces to end on the side of the tongue in the stylo-glossal and intrinsic transverse fibres (fig. 390, p. 233). It is supplied by the hypoglossal nerve and acts with the stylo-glossus in swallowing. With the opposite muscle it forms a sphincter between the buccal and pharyngeal cavities (fig. 390).

The **Intrinsic Muscles** of the tongue, of which the inferior lingualis has already been seen, may now be examined by making a transverse section of the buccal part of the tongue (figs. 377, 382). A very thin fibrous septum, the *septum linguæ*, can be distinguished in the middle line between the two genio-glossus muscles. It is free from vessels, and is followed by the surgeon when only one half of the tongue is excised. Beneath the thick and papillated mucous membrane there is a dense layer of submucous and fibrous tissue, in which the muscular fibres terminate.

FIG. 382.—EXTRINSIC AND INTRINSIC MUSCLES OF THE TONGUE. (*Kölliker.*)



1. Mucous membrane. 2. Superior longitudinal lingualis. 3. Transverse lingualis. 4, 4. Inferior longitudinal lingualis. 5, 5. Genio-hyo-glossus. 6, 6. Hyo-glossus. 7. Stylo-glossus. 8. Glands. 9. Ranine artery. 10. Septum linguæ.

The SUPERIOR LINGUAL MUSCLE (figs. 377, 382) passes from the root to the tip of the tongue beneath the submucous fibrous membrane. It is broken up into bundles by the vertical fibres of the intrinsic muscle and genio-glossus. When it contracts, it renders the surface of the tongue concave from back to front or aids in retracting the tongue.

The VERTICAL INTRINSIC fibres (figs. 377, 382) pass obliquely in the substance of the tongue from the submucous fibrous layer on the dorsum to that on the under surface of the tongue.

The TRANSVERSE INTRINSIC fibres pass outwards from the septum to the submucous tissue on the lateral aspects of the tongue. They draw the sides of the tongue together, giving the organ a rounded contour.

The intrinsic muscles are supplied by the hypoglossal nerve and lingual artery.

The pharyngeal part of the tongue will be examined more minutely when the pharynx is dissected.

DISSECTION XVII

THE PREVERTEBRAL AND RETRO-PHARYNGEAL REGIONS

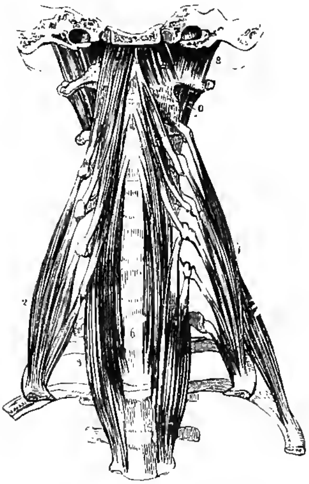
Dissection.—The muscles which lie in front of the cervical vertebræ and behind the pharynx are now to be examined. They should be exposed in the following manner. The trachea, œsophagus, and the large vessels and nerves are divided at the upper aperture of the thorax and pulled forwards. The subclavian arteries are left *in situ*. The loose connective tissue, which makes up the prevertebral and retro-pharyngeal fasciæ, is easily broken down by the handle of the knife and the anterior structures separated from the spine behind, by beginning below and working upwards until the base of the skull is reached. The student will observe how easily any inflammatory process behind the pharynx may spread downwards to the thorax in this tissue.

A section is now to be made across the skull with the saw, in such a manner as to leave the occipital part, with the insertions of the vertebral muscles, attached to the spine, while the front part of the skull and pharynx are removed. If the attachments of the sterno-mastoid, splenius capitis, trachelo-mastoid, and digastric muscles have not already been cleared away from the mastoid process, they should now be removed completely. Commencing the section opposite the posterior border of the mastoid process, first on one side, then on the other, it should be continued inwards and forwards behind the petrous bone so as to reach, and terminate at, the posterior border of the jugular foramen. When these two sections are made, the pharynx is pressed away from the spine; a chisel is inserted between the pharynx and spine, and the basi-occipital divided in front of the insertion of the prevertebral muscles (see fig. 391). As the œsophagus and pharynx are being separated from the spine, notice the loose fibrous tissue of the retro-pharyngeal space, which binds together the prevertebral and pharyngeal layers of the cervical fascia. The hypoglossal nerve is cut at its exit from the anterior condylar foramen.

The pharyngeal part of the dissection, now removed, should be wrapped up with an inner covering of oil-cloth and kept until the vertebral part has been dissected.

The Prevertebral Region.—The upper five cervical vertebræ, covered by the prevertebral muscles and fascia, and contents of the deep parotid and upper carotid spaces, lie behind the pharynx (fig. 390); the sixth and seventh cervical vertebræ are situated behind the œsophagus and common carotid arteries.

FIG. 383. — THE PREVERTEBRAL GROUP OF MUSCLES OF THE NECK. (*Wilson.*(



1. Rectus anticus major. 2. Scalenus anticus. 3. Lower oblique part of the longus colli of the right side; it is concealed superiorly by the rectus anticus major. 4. Rectus anticus minor. 5. Upper oblique portion of the longus colli. 6. Its vertical portion; the figure rests on the seventh cervical vertebra. 7. Scalenus medius; behind which is seen the scalenus posticus. 8. Rectus lateralis, left side. 9. One of the intertransversales.

The anterior convexity of the atlas and axis, accentuated by the overlying rectus capitis anticus major, projects somewhat into the posterior wall of the pharynx (Plate LIII, p. 244). The prevertebral and retro-pharyngeal fasciæ, which connect the carotid sheath of one side with that of the other, have been removed with the pharyngeal part (see fig. 282, p. 45).

The RECTUS CAPITIS ANTICUS MAJOR (fig. 383, 1), which should be examined first, *arises* from the anterior tubercles of the third, fourth, fifth, and sixth cervical transverse processes, having the same origin as the scalenus anticus. The two muscles are thus able to aid each other in action. It is *inserted* to an impression on the under surface of the basi-occipital in front of the occipital condyles (Plate XLIII, p. 10). It bends the head and upper cervical vertebræ forwards as in nodding. It is supplied from the two upper cervical nerves which emerge at its outer border (fig. 369).

The RECTUS CAPITIS ANTICUS MINOR (fig. 383, 4) is a small muscle *rising* from the anterior border of the atlas in front of the articular process, and, passing upwards and inwards, is *inserted* to the basi-occipital behind the last muscle, which must be detached to expose it, and in front of the occipital condyle (Plate XLIII, p. 10). It helps to balance the head on the atlas, and is supplied from the anterior division of the first cervical nerve, which issues at its outer border.

The Rectus Capitis Lateralis (fig. 383, 8), although belonging, not to the prevertebral, but to the inter-transverse series of muscles, should be examined next. It passes from the upper surface of the atlantoid transverse process to the under surface of the overlying jugular process of the occipital bone (Plate XLIII, p. 10). It lies behind the jugular foramen and jugular vein. It balances the head on the spine. It is supplied by the anterior division of the first cervical nerve, which appears in the deep parotid space between the adjacent borders of the rectus capitis lateralis and rectus capitis anticus minor (fig. 369, p. 196).

The Longus Colli is made up of three sets of fasciculi (fig. 383, 3, 5, 6). (1) The *inferior oblique* set *arise* from the bodies of the upper three or four dorsal vertebræ, and *end* on the anterior tubercles of the lower two or three cervical transverse processes. The *upper oblique* set *arise* from the anterior tubercles of the third to the sixth cervical transverse processes, and *end* above on the bodies of the upper five cervical vertebræ, a large part having a tendinous insertion to the tubercle on the anterior arch of the atlas. The *vertical* set *arise* with the lower oblique set and are *inserted* with the upper oblique, thus passing from vertebral bodies below to vertebral bodies above. The muscle flexes the cervical region of the spine, and is supplied by nerves from both the cervical and brachial plexuses.

Inter-transverse Muscles (fig. 383, 9).—In order to examine these, all the muscles attached to the transverse processes, both prevertebral and spinal, with the exception of the scalenus anticus, should be cleared away. There are two inter-transverse slips in each inter-transverse space, one in front of the issuing cervical nerve and one behind it (fig. 425, p. 290). The anterior passes between the anterior tubercles, the posterior between the posterior tubercles. They balance one vertebra on another and flex the cervical region of the spine laterally. When examined they should be cleared away.

The Inter-vertebral Stages of the Cervical Nerves (see fig. 425, p. 290) should now be examined. As they lie in the grooves, on the upper surfaces of the transverse processes, the cervical nerves are surrounded by extremely tough fibrous tissue, which makes them hard to clean. To make a thorough examination of one of them, say the fourth cervical, the overhanging third transverse process should be cut away with a bone forceps. The vertebral artery will then be seen to pass upwards in front of the nerves. The posterior root ganglion, with the junction of the two roots, will be exposed in the intervertebral foramen, with the bodies of the vertebræ in front and the articular processes behind. Spinal twigs from the vertebral or ascending cervical artery may be seen passing inwards on the roots to perforate the dura mater and reach the spinal cord. Intra-spinal veins also issue from the spinal canal and cord.

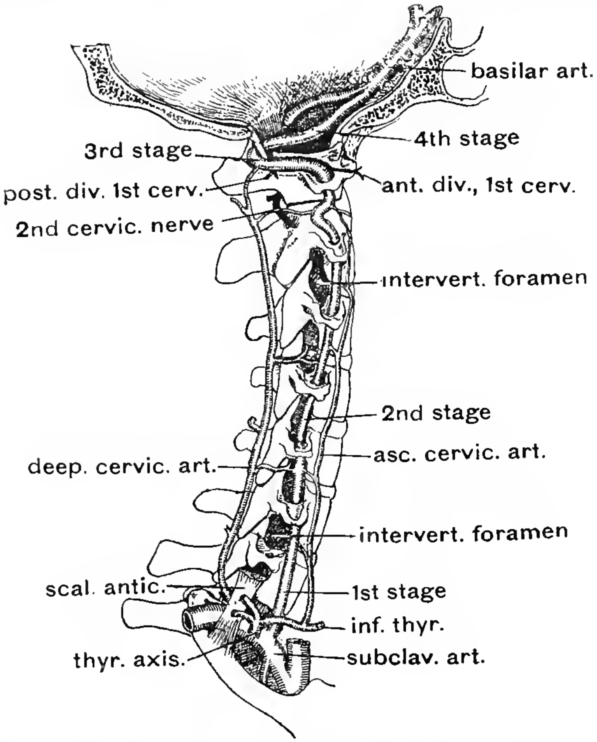
The first and second cervical nerves, owing to the peculiar structure of the atlas and axis, differ from the others in their manner of exit. The first emerges behind the lateral mass of the atlas, lying on the arch; the second behind the axio-atlantal articulation.

Stages of the Vertebral Artery.—Four distinct stages can be recognised in the course of the vertebral artery, which should now be examined (see fig. 384).

The *first stage* passes upwards from the base to the apex of the *vertebral triangle* (fig. 301, p. 89). The base of the triangle is formed by the first stage of the subclavian artery; the inner border is formed by the inferior oblique part of the longus colli; the outer border by the scalenus anticus. The neck of the first rib, the inferior cervical ganglion, the eighth cervical nerve and the first dorsal nerve are situated behind the first stage of the vertebral artery. The artery enters the foramen in the transverse process of the sixth cervical vertebra, and thus commences its second stage. The carotid tubercle, the anterior tubercle of the sixth cervical transverse process, can be felt beneath the sterno-mastoid, and affords the surgeon a guide to the termination of the first stage of the artery. On the left side the thoracic duct crosses the artery. The surgeon approaches this stage from the posterior border of the sterno-mastoid. It is deep and behind the terminal stage of the internal jugular vein. The vertebral vein joins the commencement of the innominate. Sympathetic (vaso-motor) nerves from the inferior cervical ganglion stream along the vessel to the brain and should not be forgotten in estimating the effect of ligaturing the vertebral artery.

The *second stage* lies in the foramina of the cervical transverse processes from the sixth to the first. These processes have to be cut away with a bone forceps before the artery can be well examined. It loops and bends outwards to the foramen in the transverse process of the atlas, a provision for the rotation of the head and atlas on the axis. In this stage the artery supplies twigs to the spinal cord and its membranes, to the bodies of the vertebræ, and anastomotic twigs to the deep and ascending cervical arteries.

Fig. 384.—The four stages in the course of the vertebral artery. (The course of the ascending and deep cervical arteries is also shown.)



The *third or suboccipital stage* (fig. 273, p. 20) of the vertebral artery rests on the arch of the atlas, in a groove behind and to the outer side of the lateral mass. A ligament, sometimes converted into bone, crosses the artery as it passes behind the articular process of the atlas to perforate the posterior atlanto-occipital ligament. In this stage the artery is seen in the suboccipital triangle (fig. 273, p. 20). It communicates with the occipital and deep cervical arteries (fig 384). The first cervical nerve emerges between the artery and the posterior arch of the atlas. The anterior division of the nerve passes forwards beneath the artery and to the outer side of the lateral mass of the atlas; the posterior division appears in the suboccipital triangle (fig. 384).

The *fourth or intra-cranial stage* commences as the artery perforates the posterior atlanto-occipital ligament, dura mater and arachnoid, and enters the cranial cavity. Lying then in the subarachnoid space, it crosses obliquely forwards in the foramen magnum, above the first cervical nerve and below the roots of the hypoglossal (fig. 312, p. 112). This stage terminates at the lower border of the pons Varolii by the union of the arteries of the right and left sides to form the basilar (fig. 384).

Branches from the Fourth Stage of the Vertebral Artery (see fig. 383).

(*a*) The *meningeal branch*, a twig to the membranes round the foramen magnum, is the only one that can now be seen. The rest were removed with the brain and medulla.

The other branches are (see fig. 434, p. 307) :

(*b*) The posterior spinal ;

(*c*) The anterior spinal ;

(*d*) The posterior inferior cerebellar.

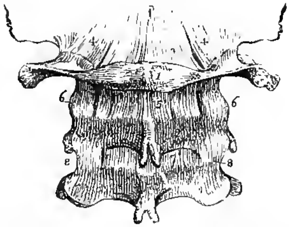
The three last named are of the greatest importance, for it is from them that the vital centres in the medulla and upper part of the cord are nourished. If one or both vertebral arteries are tied at the root of the neck, these parts are supplied from the circle of Willis, through the basilar artery (fig. 434). The communications between the vertebral and cervical arteries should not be forgotten in this connection (fig. 384).

The VERTEBRAL VEINS begin in a venous plexus lying on the dorsal aspect of the ligaments between the occipital bone and axis. Meningeal veins in the neighbourhood of the foramen magnum, communicating with the basilar and occipital sinuses, and branches from the occipital and deep cervical vein join the plexus. From this plexus three sets of veins issue—the anterior, middle and posterior vertebral veins. The *middle vertebral* vein forms a venous network on the vertebral artery ; the *anterior* accompanies the ascending cervical artery, the *posterior* the deep cervical artery. The three veins join in the vertebral triangle. The common vertebral vein ends in the innominate.

The Joints between the Head and Spine.—To examine the articulations between the occipital bone, atlas, and axis, a transverse vertical section of the part has to be made with the saw. The section has to be made across the foramen magnum and spinal canal, so as to pass behind the occipital condyles and through the pedicles of the cervical vertebræ, thus separating the laminæ from the bodies of the vertebræ.

Before commencing the dissection of the ligaments of this region, it is well to examine such a section as is shown diagrammatically in figure 386. A survey of such a section will help the student very materially to work out and identify the numerous ligaments and joints between the occipital bone, atlas, and axis. The following points should be noted (see fig. 386) :—

Fig. 385.—Posterior ligaments of the occipito-atlantal and atlanto-axial articulations. (*Wilson.*)



1. Atlas. 2. Axis. 3. Posterior occipito-atlantal ligament. 4, 4. Capsular and lateral occipito-atlantal ligament. 5. Posterior atlanto-axial ligament. 6, 6. Its capsular ligaments. 7. The first pair of ligamenta subflava. 8, 8. Capsular ligaments of the 2nd and 3rd vertebræ.

(1) *Anterior Arch of the Atlas.* The anterior occipito - atlantal ligament binds it to the occipital bone; the anterior atlanto-axial to the axis. The anterior common ligament is continued upwards to the occipital bone as the median anterior occipito-atlantal ligament.

(2) The *Odontoid Process.*—Its apex projects between the occipital condyles (fig. 388) and almost reaches the anterior edge of the foramen magnum, to which it is joined by the suspensory ligament. Synovial articular cavities separate it from the anterior arch of the atlas in front, and from the transverse ligament of the atlas behind.

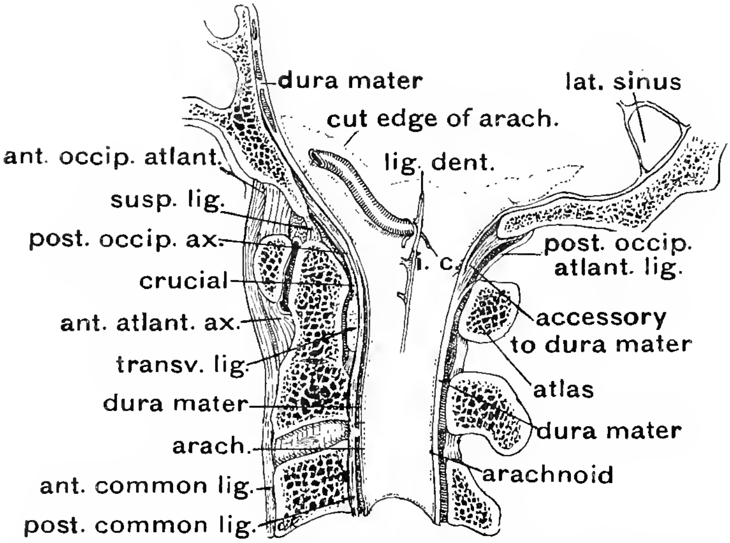
(3) The *Transverse Ligament of the Atlas.*—Vertical strands of the cruciform ligament connect it above with the occipital bone and below with the axis. The posterior axio-occipital ligament—a continuation of the posterior common ligament to the occipital bone—lies behind it. To the upper part of this ligament the dura mater adheres.

(4) The *Posterior Arch of the Atlas.*—The posterior occipito-atlantal ligament binds it to the occipital bone and the posterior

atlanto-axial to the laminæ of the axis. The dura mater is not adherent to this ligament.

Ligaments seen in the Posterior Part of the Section.—(*a*) The *Posterior Occipito-atlantal Ligament* (fig. 385, 3) is a thick membrane passing between the arch of the atlas and the posterior margin of the foramen magnum. It is pierced by the vertebral artery, first cervical nerve, meningeal and vertebral veins. The dura mater will be found non-adherent to its inner aspect (see fig. 386).

FIG. 386.—VERTICAL SAGITTAL SECTION OF THE OCCIPITAL BONE, ATLAS AND AXIS SHOWING THE LIGAMENTS WHICH BIND THEM TOGETHER IN THIS PLANE.



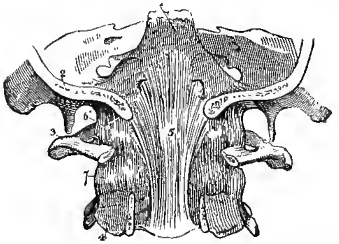
The entrance of the vertebral artery is shown within the foramen magnum, with the first cervical nerve escaping beneath it.

(*b*) *Posterior Atlanto-axial Ligament*, a fibrous membrane occupying the position of the ligamenta subflava, passes from the posterior arch of the atlas to the laminæ of the axis. The second cervical nerve pierces it behind the body and articular surfaces of the axis.

The ligaments between the laminæ, spines, and articular processes of the cervical vertebræ do not differ materially from those in the dorsal and lumbar regions. The capsular ligaments, surrounding the articular processes, are loose, and allow gliding movements between the obliquely set articular processes.

Ligaments seen in the Anterior Part of the Section.—The Posterior Common Ligament binds the cervical vertebræ together on the posterior aspect of their bodies, and is continued upwards, without attachment to the atlas, to end on the anterior and upper margin of the foramen magnum (figs. 386 and 387). When the thecal layer of dura mater is lifted upwards it is found to become adherent above the level of the atlas to this ligament within the foramen magnum (fig. 386). The posterior common ligament is widest and strongest in the cervical region; the part that passes from the body of the axis to the occipital bone is distinguished as the posterior axio-occipital ligament (fig. 387).

Fig. 387.—Upper part of the vertebral canal, opened from behind in order to show the posterior occipito-axial ligament. (*Wilson.*)



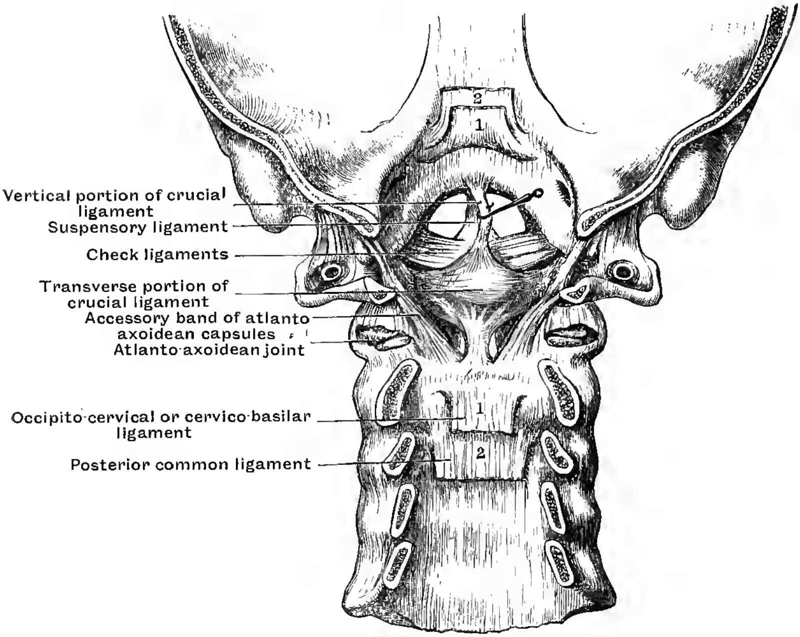
1. Basilar portion of the sphenoid bone. 2. Section of the occipital bone. 3. Atlas, its posterior arch removed. 4. Axis, posterior arch removed. 5. Posterior occipito-axial ligament, rendered prominent at its middle by the projection of the odontoid process. 6. Lateral and capsular ligament of the occipito-atlantal articulation. 7. Capsular ligament of the articular process of the atlas and axis.

Alar, Check or Lateral Odonto-occipital Ligaments. When the last ligament is completely dissected off, the apex of the odontoid process will be seen to project between the occipital condyles (fig. 388). From each lateral aspect of the apex a check ligament passes almost transversely outwards, just above the transverse ligament, to the inner aspect of each occipital condyle. They are extremely strong, and it will be seen, if the occipital condyle and atlas be rotated on the odontoid process, that they allow a movement little more than the third of a right angle to each side—about sixty degrees in all. The student is familiar with the fact that he can look over his shoulder, a movement of quite a right angle, but only a third of this movement is executed between the axis and atlas; the remaining two-thirds are obtained by movements between the other cervical vertebræ.

The Transverse Ligament of the Atlas (fig. 388) is seen passing behind the odontoid process almost parallel and in contact with the check ligaments. It passes from the inner aspect of one lateral mass of the atlas to the other, and, with the anterior arch, forms the socket for the pivot-like odontoid process. A synovial facet separates the odontoid process from the transverse ligament; another separates the odontoid from the anterior arch of the atlas. If the head be forcibly jerked forwards, as takes place in hanging, the odontoid process may break or rupture the transverse ligament and plunge into the substance of the cord. The transverse ligament is held in position by *vertical fibres* which pass to the occipital bone above and body of the axis below (fig. 388). With the transverse ligament they form a cross—hence the name *cruciform* or crucial sometimes given to this combination of ligaments. The vertical fibres probably represent a deep stratum of the posterior common ligament. When the upper vertical fibres are reflected downwards the next ligament will be seen.

FIG. 388.—VERTICAL TRANSVERSE SECTION OF THE SPINAL COLUMN AND THE OCCIPITAL BONE TO SHOW THE LIGAMENTS BETWEEN THE AXIS, ATLAS, AND OCCIPITAL BONE. (*From Morris's 'Anatomy.'*)

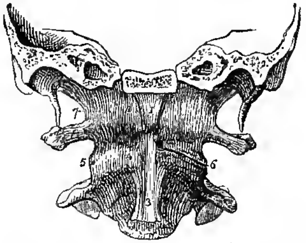
(The cervico-basilar (1), though shown as a distinct stratum, is really the deeper part of the posterior common ligament (2).)


2
1
Vertical portion of crucial ligament
Suspensory ligament
Check ligaments
Transverse portion of crucial ligament
Accessory band of atlanto axoidean capsules
Atlanto-axoidean joint
1
Occipito-cervical or cervico-basilar ligament
2
Posterior common ligament

The Suspensory Ligament passes from the apex of the odontoid to the anterior margin of the foramen magnum. It is short and easily broken.

Anterior Atlanto-axial and Occipito-atlantal Ligaments (see figs. 386, 389).—Turning now to the upward continuation of the anterior common ligament of the spine, it will be found to become narrower and weaker as it passes upwards. The part which joins the axis to the atlas forms the *anterior atlanto-axial ligament*; only the median fibres, in the form of a rounded cord attached to the anterior tubercle of the atlas, is continued upwards to the occipital bone. This forms the *median* part of the anterior occipito-atlantal ligament. The *lateral* parts are membranous, filling the interval between the anterior arch of the atlas and the corresponding border of the foramen magnum.

Fig. 389.—Anterior view of the ligaments connecting the atlas, axis, and occipital bone. (*From Wilson.*)



1. Anterior median occipito-atlantal ligament. 2. Anterior occipito-atlantal ligament. 3. Commencement of the anterior common ligament. 4. Anterior atlanto-axial ligament, continuous inferiorly with the commencement of the anterior common ligament. 5. One of the atlanto-axial capsular ligaments; that on the opposite side has been removed to show the approximated surfaces of the articular processes (6). 7. One of the occipito-atlantal capsular ligaments. The most external of these fibres constitute the lateral occipito-atlantal ligament.

The Lateral Occipito-atlantal Ligament passes from the transverse process of the atlas to the jugular process of the occipital bone, outside the articulation between the occipital condyle and articular mass of the atlas. It strengthens that articulation.

The Capsular Ligaments which surround the articular surfaces are now to be examined. That between the lateral mass of the atlas and occipital condyle will be found to surround the joint and allow free *nodding* and *lateral* movements. The occipital condyles are much larger than the corresponding articulations on the atlas, and the two articular surfaces commonly fit best together when the face is turned slightly to the side and downwards—a position of repose.

The capsular ligaments which surround the articulations between the atlas and axis also are loose. An accessory band passes on each side from the inner aspect of the lateral mass of the atlas to the posterior surface of the body of the axis at the base of the odontoid (fig. 388). The atlantal surface is the larger, and glides over the smaller axial surface in rotation of the head.

This joint will be observed to lie in front of the second cervical nerve. A corresponding articular cavity of minute size will be found in the lateral aspect of each cervical intervertebral disc, between the upturned lateral lips of the lower vertebra and the bevelled edges of the vertebra above.

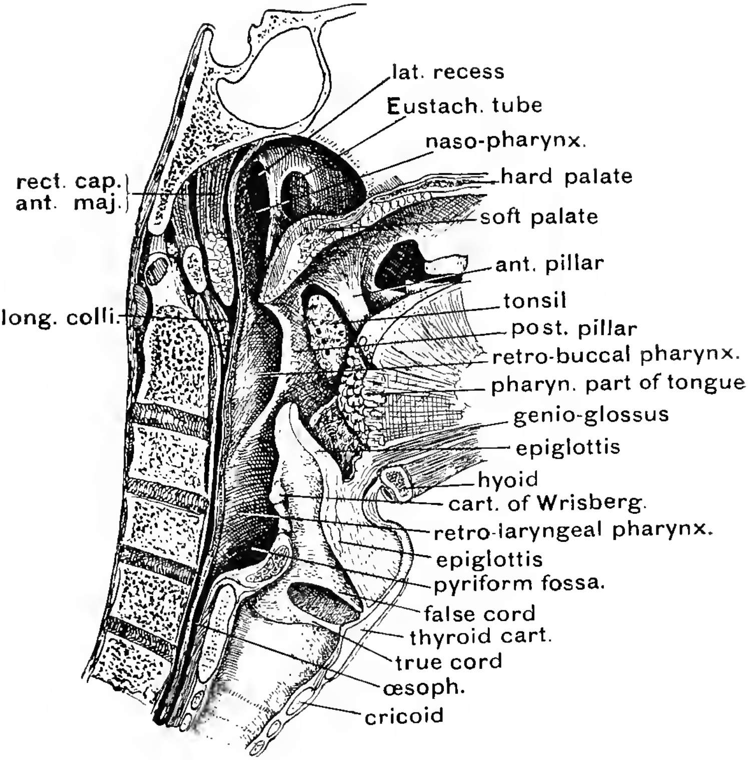
The cervical bodies and intervertebral discs are shallow, but otherwise do not differ from those of the dorsal and lumbar regions.

DISSECTION XVIII

THE PHARYNX AND MOUTH

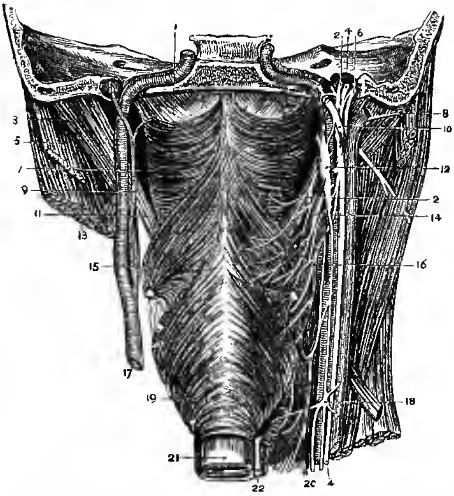
Cavity of the Pharynx. SHAPE.—In order to dissect the muscular wall of the pharynx, the student must render it tense by stuffing the cavity from the mouth with tow. By doing this he may form a wrong impression as to the shape and relationships of its cavity, and to correct this he should consult, before commencing dissection, sections of the part such as are shown in fig. 282, p. 42, and Plate LIII, p. 244. He will see, in transverse section, that the posterior wall of the pharynx is flat and almost in contact with the anterior wall, while the lateral walls are merely angular junctions between the anterior and posterior. In a vertical section (fig. 390) he will observe that the cavity falls into three natural spaces or compartments, one below the other. The RETRO-NASAL space communicates with the nasal cavities by the posterior choanæ or nares, and is partially separated from the RETRO-BUCCAL SPACE by the soft palate. The retro-nasal space can only be partially obliterated, the superior constrictor surrounding merely its lower part; during swallowing it is completely shut off from the retro-buccal space by the soft palate. The RETRO-BUCCAL SPACE communicates with the mouth between the anterior pillars of the fauces (fig. 390), formed by the palato-glossal muscles, and is bounded in front by the pharyngeal surface of the tongue. The retro-buccal space can be completely obliterated by the contraction of the muscular walls of the pharynx. At the level of the glosso-epiglottic folds it becomes continuous with the RETRO-LARNYGEAL space, which communicates in front with the larynx between the aryteno-epiglottic folds (fig. 390). The retro-laryngeal space ends in the œsophagus, at the level of the disc between the fifth and sixth cervical vertebræ. The great horns of the hyoid and the epiglottis keep this space open in all conditions of the pharynx. In natural respiration the uvula of the soft palate hangs down towards the epiglottis, and a channel is formed for the respiratory air to pass from the retro-nasal space to the retro-laryngeal.

FIG. 390.—A VERTICAL SAGITTAL SECTION OF THE PHARYNX TO SHOW ITS THREE DIVISIONS AND THE STRUCTURES SEEN IN EACH.



PHARYNGEAL FASCIA.—Before commencing the dissection of the pharyngeal walls, all the great structures which lie in the subparotid space—the 9th, 10th, 11th, and 12th pairs of cranial nerves, the superior cervical ganglion, and the great vessels—should again be examined and cut away one by one (see fig. 391). With them is removed a layer of fascia which covered the prevertebral muscles when the parts were *in situ*. It forms the prevertebral layer of the cervical fascia (fig. 368, p. 195). The pharyngeal fascia will be found forming an outer sheath for the constrictor muscles, and has to be dissected carefully off before the scattered and intricate fasciculi of these muscles can be made out. It is continuous in front with the buccal fascia covering the buccinator muscle.

FIG. 391.—DISSECTION OF THE CONSTRICTOR MUSCLES OF THE PHARYNX WITH THE VESSELS AND NERVES IN RELATION WITH THEM. (*Heath.*)



1. Pharyngeal aponeurosis. 2, 2. Glosso-pharyngeal nerve. 3. Posterior belly of digastric. 4, 4. Vagus nerve. 5. Splenius capitis. 6. Spinal-accessory nerve. 7. Superior constrictor muscle. 8. Internal jugular vein. 9. Ascending pharyngeal artery. 10. Hypoglossal nerve. 11. Stylo-pharyngeus. 12. Superior ganglion of sympathetic. 13. Sterno-mastoid. 14. Pharyngeal branch of pneumogastric. 15. Middle constrictor. 16. Superior laryngeal nerve. 17. Common carotid artery. 18. Middle ganglion of sympathetic. 19. Inferior constrictor. 20. Cardiac nerves. 21. Œsophagus. 22. Recurrent laryngeal nerve.

In the connective tissue covering the pharynx will be found the terminal filaments of the *pharyngeal plexus of nerves* formed by branches of the vagus, glosso-pharyngeal and superior cervical ganglion (fig. 391). Numerous branches of the ascending pharyngeal and the ascending palatine arteries, with the venous plexus in which the pharyngeal veins arise, have also to be cleared away to show the muscles.

Constrictors of the Pharynx.—There are three constrictor muscles of the pharynx, viz. superior, middle, and inferior (fig. 391, 7, 15, 19). Besides these, two other muscles act directly on it, the stylo-pharyngeus, already examined (p. 194), and the palato-pharyngeus, to be examined in connection with the palate (p. 242).

The INFERIOR CONSTRICTOR (see figs. 391 and 367, p. 193) arises from (*a*) the outer aspect of the cricoid cartilage, behind the thyroid articular facet; (*b*) the outer surface of the thyroid cartilage, in front of the posterior border. The fibres diverge and end on the posterior raphe of the pharynx, overlapping the insertion of the middle constrictor above, and becoming continuous with the muscular fibres of the œsophagus below. It is the constrictor of the retro-laryngeal space.

The MIDDLE CONSTRICTOR (figs. 393 and 367) arises from the upper border of the great horn of the hyoid, near the lesser horn, and also from the lesser horn, its origin underlying the hyoglossus muscle. It expands as it passes backwards to end on the median raphe of the pharynx, under the inferior constrictor and over the superior constrictor. The stylo-pharyngeus muscle enters the wall of the pharynx beneath its upper border, and ends on the posterior border of the thyroid cartilage and pharyngeal aponeurosis. The middle constrictor acts on the retro-buccal and retro-laryngeal parts of the space, and forces the food downwards in deglutition.

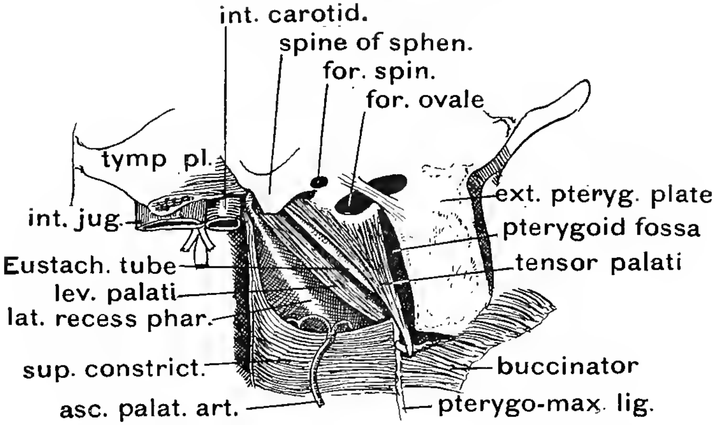
The SUPERIOR CONSTRICTOR (figs. 391 and 367, p. 193) arises in front from (*a*) the posterior border of the lower half of the internal pterygoid plate; (*b*) from the fibrous tissue round the groove on the hamular process for the tensor palati; (*c*) from the pterygo-maxillary ligament; (*d*) from the posterior end of the mylo-hyoid ridge; (*e*) a few fibres arise from the side of the tongue. It passes backwards, its lower fibres under the insertion of the middle constrictor, and meets with the opposite muscle in the median raphe of the pharynx; the uppermost fibres are reflected to the pharyngeal spine on the under surface of the basi-occipital (fig. 391). In the act of swallowing, the superior constrictor contracts on the bolus of food which the tongue has placed within its grasp and forces it downwards. The contraction of its upper fibres, which arise from the internal pterygoid plate, with the elevation of the soft palate and contraction of the palato-pharyngeus, cuts off communication between the retro-nasal and retro-buccal parts of the space.

Retro-nasal Fibrous Hiatus, or **Sinus of Morgagni.**—It will be observed that the upper part of the retro-nasal space cannot be compressed, for there the muscular wall is wanting. The hiatus between the upper border of the superior constrictor and base of the skull, commonly known as the *Sinus of Morgagni*, is completed by the fibrous lining of the pharynx—

the pharyngeal aponeurosis. The hiatus appears in the floor of the zygomatic space (fig. 369, p. 196). The Eustachian tube and the levator palati pass obliquely forwards and inwards to the pharynx through the fibrous space (fig. 392). The lateral recess of the pharynx projects outwards in it behind the Eustachian tube. The ascending palatine artery loops over the upper border of the superior constrictor to reach the palate (fig. 369).

The PHARYNGEAL APONEUROSIS forms the inner fibrous sheath of the constrictor muscles and is to be exposed by carefully reflecting the constrictor fibres. Above it is much thicker than below, and fills the retro-nasal hiatus between the base of the skull and upper margin of the superior constrictor. Through the aponeurosis, especially its median posterior thickening, the pharynx is suspended from the base of the skull. In the submucous tissue, between the aponeurosis and the mucous membrane of the pharynx, there is a plexus of veins draining into the veins in the pharyngeal fascia. In front, the pharyngeal aponeurosis is continuous with the pterygo-maxillary ligament and the inner sheath of the buccinator muscle. The pterygo-maxillary ligament may be regarded as a thickening of the aponeurosis.

FIG. 392.—A DIAGRAM OF THE BOUNDARIES AND STRUCTURES WITHIN THE SINUS OF MORGAGNI.



The **Interior of the Pharynx** (see figs. 390 and 393) should now be viewed by opening the cavity along the posterior median raphe and removing the tow within. To see the upper part it will be necessary to divide the posterior wall transversely along its attachment to the skull. The various spaces or divisions of the pharynx have already been indicated (p. 232).

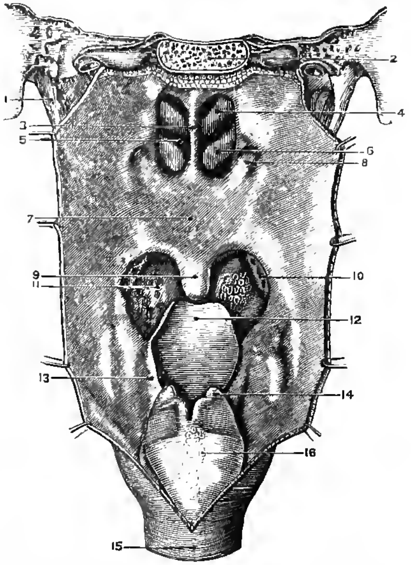
Within the Retro-nasal Space or Naso-pharynx the student should note the following points:

(1) The funnel-shaped opening of the Eustachian tube on each lateral wall, exactly on a level with the inferior turbinate process. It is equidistant from the roof of the pharynx, the posterior wall, soft palate and inferior turbinate. Its posterior border is prominent and bounds the lateral recess in front.

(2) The lateral recess of the pharynx (fossa of Rosenmüller) behind the Eustachian tube (fig. 390).

(3) The abundance of lymphoid follicles, unless the subject be aged, situated in the mucous membrane on the posterior wall, and which in children may hypertrophy (pharyngeal adenoids) and obstruct the respiratory passage, besides pressing on and blocking the Eustachian tube (fig. 394). The lymphoid follicles of the retro-nasal space form the pharyngeal tonsil.

Fig. 393.—Pharynx laid open from behind. (*Sappey.*)



1. Styloid process. 2. Body of occipital bone. 3. Septum nasi. 4. Middle turbinate bone. 5. Posterior naris. 6. Inferior turbinate bone. 7. Soft palate. 8. Eustachian tube. 9. Uvula. 10. Tonsil. 11. Back of tongue. 12. Epiglottis. 13. Aryteno-epiglottidean fold. 14 Tip of arytenoid cartilage. 15. Œsophagus. 16. Back of cricoid cartilage.

(4) In the anterior wall of the space are the openings of the posterior nares or choanæ (fig. 393). The nasal septum separates the openings; within the nasal cavities are seen the posterior ends of the inferior and middle turbinate processes. The naso-pharynx is lined by ciliated epithelium.

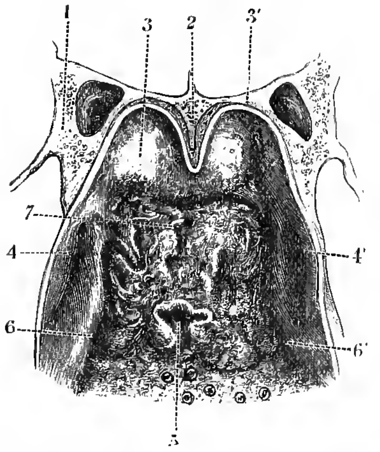
(5) The Median Recess of the pharynx (bursa pharyngea)

is a slit-like depression in the roof of the naso-pharynx (fig. 394). Its significance is unknown.

In the Retro-buccal Space or Bucco-pharynx may be observed:

(1) The posterior pillar of the fauces, formed by the palato-pharyngeus, proceeding obliquely downwards and backwards from the posterior margin of the palate (fig. 390). The two pillars, with their contained muscles, help to form a sphincter between the retro-buccal and retro-nasal spaces.

Fig. 394.—The posterior wall of the pharynx. (*Luschka.*)



1. Sphenoid. 2. Vomer. 3. Posterior end of nasal fossa. 3.' Cut edge of mucous membrane. 4, 4'. Opening of Eustachian tube. 5. Opening of median recess or bursa pharyngea. 6, 6'. Recessus pharyngeus lateralis. 7. Adenoid tissue of pharynx.

(2) The pharyngeal surface of the tongue (fig. 393, 11), forming the anterior wall of the space and covered by numerous lymphoid nodules containing mucous glands.

(3) The circumvallate papillæ are situated at the brink of the pharynx between the buccal and pharyngeal parts of the tongue (fig. 390).

(4) The epiglottis projects behind the base of the tongue, to which it is bound by the median and lateral glosso-epiglottidean folds.

(5) The tonsil, situated on the lateral wall of the bucco-pharynx, above the pharyngeal part of the tongue (fig. 390). In this space the lining epithelium is stratified and non-ciliated.

In the Retro-Laryngeal Space note:—

(1) The upper aperture of the larynx bounded laterally by the aryteno-epiglottic folds (fig. 393). Above, these folds end on the sides of the epiglottis which bounds the aperture in front; below they project over the apices of the arytenoid cartilages and the slight cartilages situated on the apices (cornicula laryngis or cartilages of Santorini). A slight nodular swelling may be observed in each; it is caused by a nodule of yellow fibro-cartilage situated in them (the cartilage of Wrisberg). The mucous membrane is bound to the folds

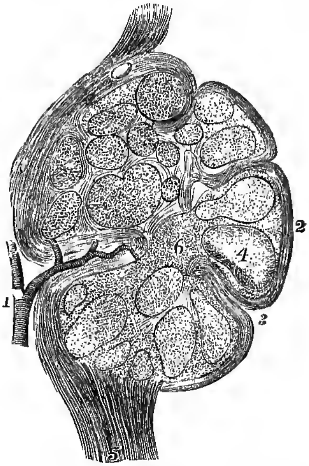
by a loose submucous tissue, which in disease may become so dropsical as to completely occlude the laryngeal aperture.

(2) Between the aryteno-epiglottic folds and the expansion of the wings of the thyroid cartilage, on each side, is the pyriform fossa (fig. 390), a recess in which foreign bodies may lodge and cause suffocation. This space also is lined by stratified epithelium.

(3) The opening of the œsophagus behind the cricoid cartilage.

The **Tonsil** is situated on the lateral wall of the bucco-pharynx, below the soft palate, and above the pharyngeal part of the tongue (fig. 390). The anterior pillar of the fauces, containing the palato-glossus muscle, bounds it in front, and the posterior pillar, containing the palato-pharyngeus muscle, passes downwards behind it (fig. 368, p. 195). In old people the tonsil is small and lies in a fossa—the tonsillar recess—but in young people it is large, and even in health may be distinctly seen projecting beyond the level of the anterior pillar. They are apt to hypertrophy in children, and may expand so as almost to meet across the space. They may also project into the soft palate and interfere with the action of its muscles. There is usually a well-marked supra-tonsillar recess, across which a fold of membrane (the plica triangularis) may be seen to pass from the anterior pillar (fig. 390). On the tonsil itself a number of crypts are to be seen opening on its surface. These crypts are surrounded by follicles of lymphoid tissue (fig. 395).

FIG. 395.—VERTICAL SECTION OF THE TONSIL. (*H. E. Clark.*)



1. Hilum with vessel entering it. 2. Epithelial external layer. 3. Mucous crypt. 4. Lymphoid nodule. 5. Submucous tissue of the fauces terminating in the tonsil. 6. Interstitial connective tissue.

When the mucous membrane is reflected from the muscles which lie within the pillars of the fauces and the gland dissected out, the tonsil will be found to rest on the pharyngeal aponeurosis and superior constrictor, behind the pterygo-maxillary ligament (fig. 368, p. 195). It lies beneath the angle of the jaw. The facial artery, as it bends under the jaw, lies below and to its outer side; the ascending palatine artery passes close to it; the internal carotid artery is three-quarters of an inch behind and to its outer side. The tonsillar arteries are derived from the facial, ascending palatine, and lingual. The glosso-pharyngeal affords its nerve supply. Its lymphatics, which are specially important as the tonsil is often the point at which infective processes start, end in the uppermost of the deep cervical lymphatic glands. These glands are situated under the anterior border of the sterno-mastoid and behind the angle of the jaw.

Soft Palate.—In the dissection of this part the student should have by him the base of a skull, to which he will have frequently to refer if he would understand the rather complicated arrangement of the palatal muscles.

The soft palate will be seen to form a continuation backwards of the roof of the mouth and floor of the nose, so as to form a sloping shelf, which, when the parts are in a state of rest, partly separates the naso-pharynx from the bucco-pharynx (fig. 390). It ends behind in a median process—the uvula. The uvula terminates in a thin, narrow fold of the mucous membrane.

Making the palate tense by passing a hook within the uvula and drawing it down and back, the student begins dissecting by a median incision along the dorsum of the palate. As the mucous membrane is reflected outwards and upwards, the thickness of the submucous tissue will be noted and in it the presence of numerous mucous glands which lubricate the palate.

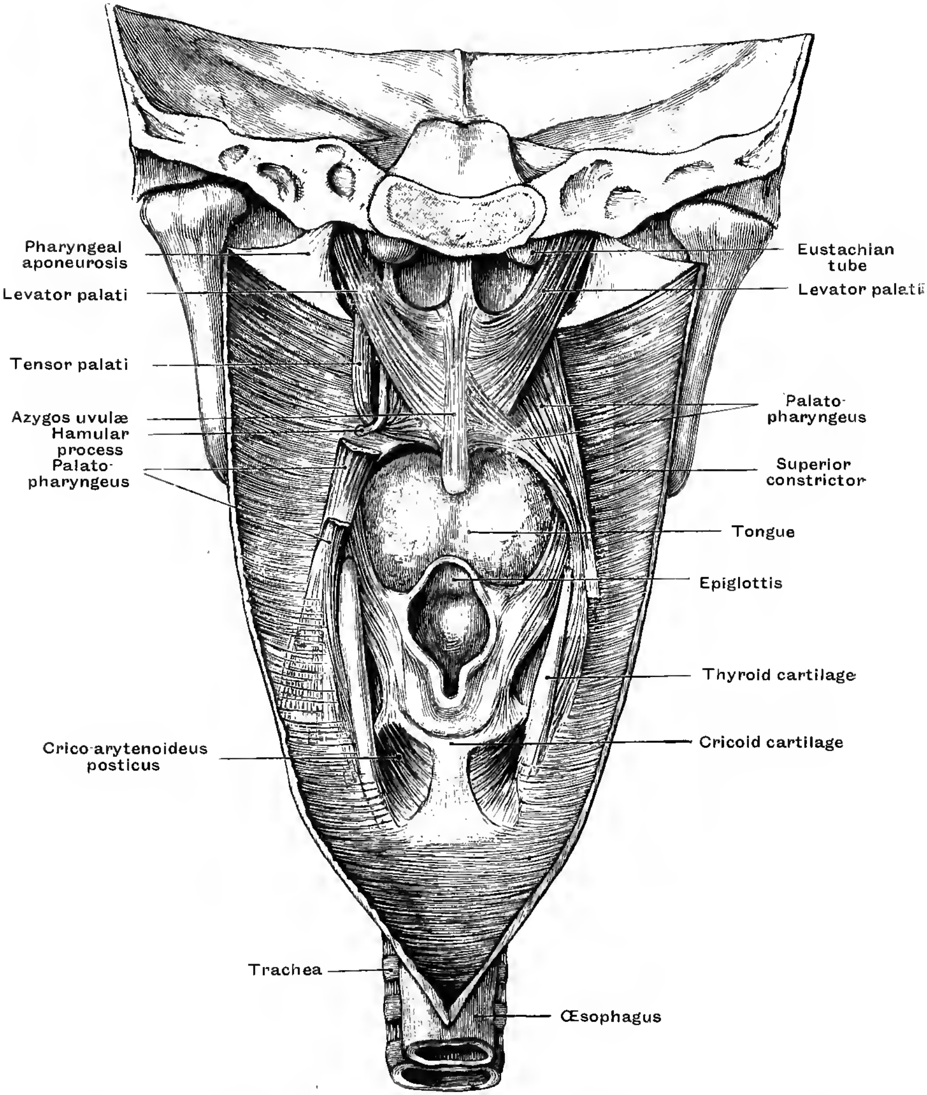
Muscles of the Soft Palate.—There are five pairs of muscles in the soft palate. They are:

(1) Azygos Uvulæ; (3) Tensor Palati;
(2) Levator Palati; (4) Palato-pharyngeus;
(5) Palato-glossus.

The Azygos Uvulæ (see fig. 396) is situated beneath the submucous tissue at each side of the median line on the upper aspect of the palate. In front it is attached to the edge of the hard palate; behind it ends in the uvula. It can shorten and elevate the uvula.

The Levator Palati will be found beneath the Eustachian tube, running inwards, forwards, and slightly downwards (figs. 396, 397). It ends on the upper surface of the palate by uniting, amidst fibrous tissue, with the muscle of the opposite side. Its origin is from the lower surface of the petrous bone, behind and internal to the canal within that bone for the

FIG. 396.—VIEW OF MUSCLES OF SOFT PALATE AS SEEN FROM WITHIN THE PHARYNX. (*From Morris's 'Anatomy.'*)



Eustachian tube (Plate XLIV, p. 14). As it becomes thicker when it contracts and lifts the palate, it must also compress the overlying tube. It enters the pharynx at the retro-nasal fibrous hiatus (fig. 392). When examined, it should be cut through near its palatal end and turned outwards. It is divided near its insertion in the operation for cleft palate.

The TENSOR PALATI was seen in the floor of the zygomatic space (fig. 392). It continues backwards the plane of the internal pterygoid plate, and its lower part lies beneath the internal pterygoid muscle. At one end its wide attachment extends from the scaphoid fossa along the anterior border of the Eustachian tube to the spine of the sphenoid (fig. 392). At its other extremity it ends in the fibrous basis or aponeurosis of the palate and the lower edge of the posterior margin of the hard palate, and under the insertion of the levator palati (Plate LI, p. 152). Between these attachments, it gains access to the pharynx by turning round the hamular process, on the trochlear surface of which its tendon moves, surrounded by a small synovial sheath. It renders the palate tense, but the origin of some of its fibres from the tube probably also permits it to act as a dilator of the Eustachian tube. The *palatal aponeurosis*, in which the tensor ends, makes up the fibrous central basis of the soft palate (fig. 397).

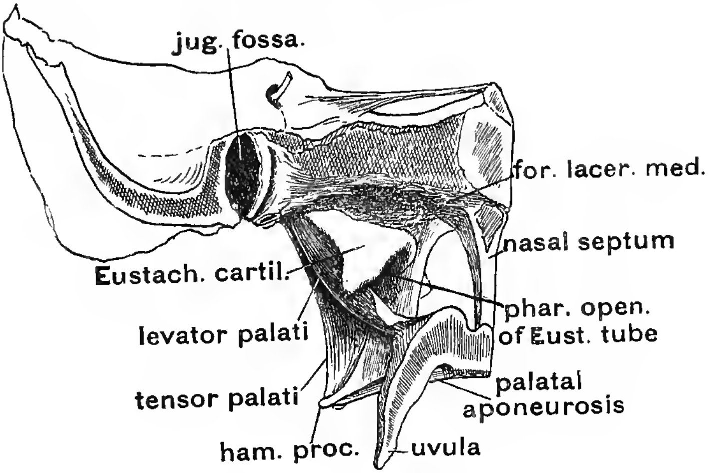
The PALATO-PHARYNGEUS (fig. 396) arises within the palate. A slight part of its origin overlies the insertion of the levator palati, but its greatest part springs from beneath the insertion of that muscle from the palatal aponeurosis and edge of the hard palate. It passes backwards within the pharynx, forming the posterior pillar of the fauces, and spreads out, as it terminates in the pharyngeal aponeurosis and posterior border of the thyroid cartilage, within the middle and inferior constrictors. In swallowing, both muscles contract and, with the soft palate between them, cut off the bucco-pharynx from the naso-pharynx.

The SALPINGO-PHARYNGEUS is not constant. It is a band of the last muscle which arises from the inner end of the cartilage of the Eustachian tube. The muscle is contained in a vertical fold which descends from the posterior margin of the tube (fig. 390).

The BUCCAL SURFACE OF THE PALATE.—The part should now be turned in such a way as to allow the under surface of the palate to be examined. The tongue and larynx should be detached. The mucous membrane on the buccal surface of the palate should be reflected, commencing by a median incision. The submucous tissue, a continuation backwards of the corresponding tissue of the hard palate, will be found to be extremely thick and dense. It contains numerous mucous glands.

The PALATO-GLOSSUS, a thin muscular strand, will be found to arise from the under surface of the soft palate and form the anterior pillar of the fauces. Its termination will be seen on the side of the tongue, over the insertions of the stylo-glossus and hyoglossus. Some of its terminal fibres are continued into the transverse intrinsic muscle of the tongue. The opposite muscles act as a sphincter between the mouth and bucco-pharynx.

FIG. 397.—THE EUSTACHIAN CARTILAGE, TENSOR PALATI, AND LEVATOR PALATI MUSCLES. (*K. F. Lund.*)



The DESCENDING OF SUPERIOR PALATINE ARTERY (a branch of the internal maxillary), and the POSTERIOR PALATINE NERVES (from the spheno-palatine ganglion), should be looked for as they escape in the hard palate from the posterior palatine canal (fig. 409, p. 262). The external and small posterior palatine nerves, if found, for they are minute, escape by separate foramina and pass to the soft palate. They are purely sensory. A branch from the descending palatine artery will also be found.

The Ascending Palatine Artery, a branch of the facial, has already been seen to turn over the upper border of the superior constrictor muscle and enter the palate (fig. 392, p. 236). Branches may also be found from the ascending pharyngeal.

The Muscles of the Palate have the following nerve supply: the palato-pharyngeus, azygos uvulæ, and levator palati are supplied from the pharyngeal plexus (through the spinal accessory); the palato-glossus from the hypoglossal; the tensor palati from the otic ganglion (fig. 366, p. 191).

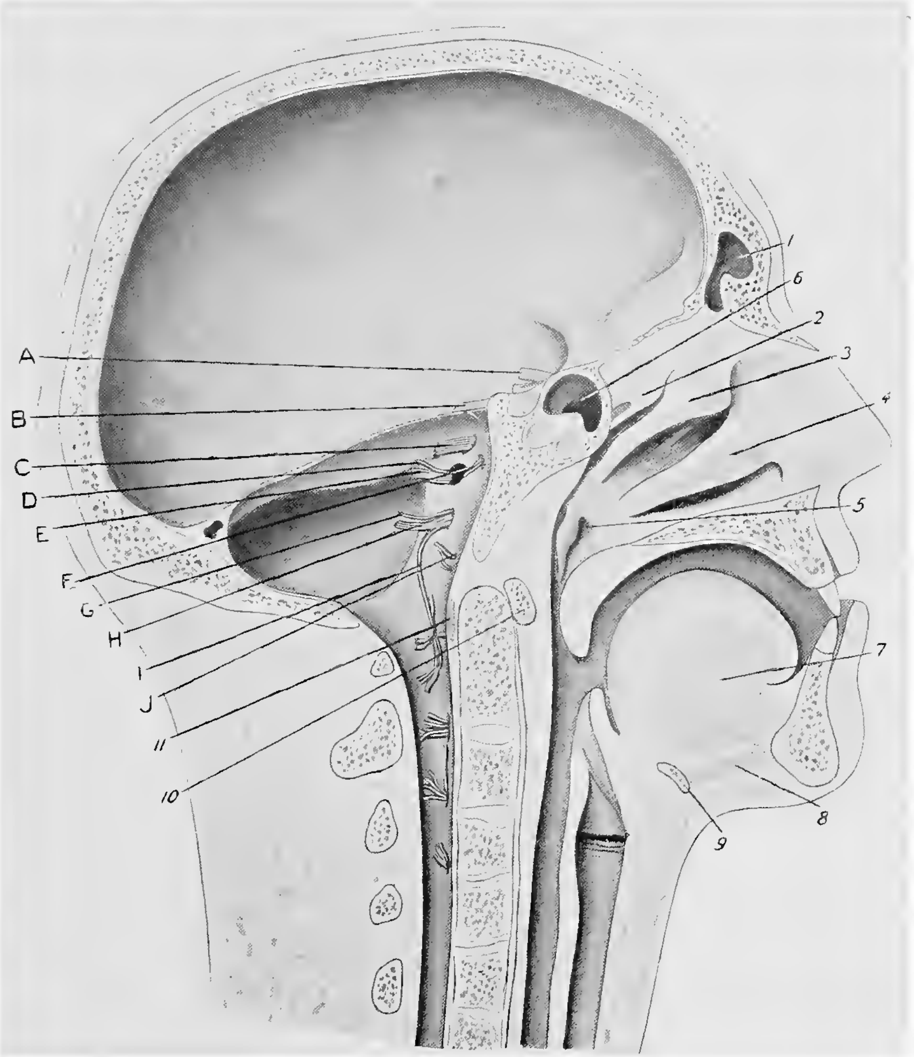
Pharyngeal and Buccal Aspects of the Tongue.—A *V-shaped sulcus*, with its apex directed backwards, marks the junction of the buccal and pharyngeal parts of the tongue (fig. 390). At the apex of the sulcus is the *foramen cæcum*, the point from which the isthmus of the thyroid gland was developed (fig. 379, p. 214). Arranged in an irregular row along the posterior margin of the buccal part are the *circumvallate papillæ*, round which the taste buds are situated. On the dorsum of the buccal part of the tongue will be seen the *filiform papillæ*, with their thick epithelial coats. Sparsely scattered among them are the larger *fungiform papillæ*. On the dorsum of the pharyngeal part there are no papillæ, only nodular elevations composed of lymphoid tissue with mucous glands imbedded in each rounded mass. On the side of the tongue, anterior to the termination of the anterior pillar, are certain linear ridges, vestiges of the *papillæ foliatæ* (fig. 379, p. 214). On the sides of the tongue and under the apex the mucous membrane is thin and smooth, with here and there groups of mucous glands imbedded in the submucous tissue. One of these groups lies beneath the apex of the tongue (subapical group).

The sublingual space, covered by the mucous membrane on the floor of the mouth, lies under the anterior half of the buccal part of the tongue; under the mucous membrane at each side of the remaining part is the submaxillary space. The frenum linguæ, a median fold of the buccal mucous membrane, helps to bind the apical part of the tongue to the floor of the mouth.

The median and lateral glosso-epiglottic folds bind the epiglottis to the pharyngeal part of the tongue.

PLATE LIII

VERTICAL MESIAL SECTION OF THE HEAD AND NECK, TO SHOW THE NASAL, BUCCAL, AND PHARYNGEAL CAVITIES AND EXIT OF THE CRANIAL NERVES. (*Hughes.*)



1. Frontal sinus. 2. Superior turbinate. 3. Middle turbinate. 4. Inferior turbinate. 5. Opening of Eustachian tube in the naso-pharynx. 6. Sphenoidal sinus. 7. Genio-hyo-glossus. 8. Genio-hyoid. 9. Hyoid. 10. Body of atlas. 11. Transverse ligament of atlas.

Cranial Nerves.—A. Optic. B. Third (Oculomotor). C. Fifth (Trigeminal). D. Seventh (Facial). E. Eighth (Auditory). F. Sixth. G. Ninth (Glosso-pharyngeal). H. Tenth (Vagus). I. Eleventh (Spinal accessory). J. Twelfth (Hypoglossal).

NERVES AND VESSELS OF THE TONGUE (figs. 375, p. 209, and 381, p. 217).—The tongue is supplied with blood by the two lingual arteries and their ramifications; the blood is returned to the internal jugulars by the lingual veins. The hypoglossal are the motor nerves of the tongue; the lingual branch of the fifth, the chorda tympani, and glosso-pharyngeal form its sensory pathways. The lymphatic vessels pass to the submaxillary and superior deep cervical glands.

The HYOID is the skeletal basis of the tongue. Its muscles, which have been seen in the dissection of several regions, are so arranged as to be able to move it in all directions, and through it the tongue. Only one muscle arises from it to terminate in the tongue—the hyoglossus.

The THYRO-HYOID MEMBRANE (fig. 390, p. 233) binds the hyoid to the thyroid cartilage, and when examined the membrane will be seen to be attached to the postero-superior border of the body of the hyoid. In upward movements of the larynx, the thyroid cartilage may thus pass behind the body of the hyoid. There is a bursa between the membrane and body of the hyoid. The membrane is thickened in the median line in front, and posteriorly between the ends of the great horns of the hyoid and the superior cornua of the thyroid cartilage (fig. 401). In the posterior ligaments a small cartilage, cartilago tritacea, may be present.

ATTACHMENTS OF THE EPIGLOTTIS.—A superficial examination will satisfy the student that the epiglottis is so fixed to the surrounding parts that it is impossible for it to act as a trap-door, as has been supposed, for the aperture of the larynx during deglutition. Its lateral margins are continuous with the aryteno-epiglottic folds. By its narrow root, to be seen afterwards, it is bound within the anterior angle of the thyroid cartilage, and must in the main follow the movements of that cartilage. If the glosso-epiglottidean folds and the mucous membrane which binds the epiglottis to the tongue be divided, a layer of fibrous tissue, best seen on section (fig. 390, p. 233), will be found in front of the lower half of the epiglottis, attaching its stalk to the angle of the thyroid cartilage, thyro-hyoid membrane, and loosely to the hyoid bone. The lower fibres of the genio-hyo-glossus act on the epiglottis through this fibrous layer or band (fig. 390). The epiglottis is also bound to the tongue by the median and lateral glosso-epiglottic folds.

THE HARD PALATE AND TEETH

The Hard Palate.—The thickness and density of the fibrous tissue which binds the mucous membrane to the palate makes the dissection of this part difficult. The hard palate forms the roof of the mouth.

SURFACE MARKINGS.—In the position of rest the dorsum of the buccal part of the tongue fills the concavity of the palate. Behind the incisor teeth, where the palatal arch slopes upwards and backwards, and against which the tip of the tongue comes in contact, there is a slight papilla—the incisive papilla (fig. 409, p. 262). In some animals the right and left naso-palatine ducts open on the papilla; but in man the lower ends of these ducts are closed, but the upper openings will be seen in the floor of the nose. Two or three transverse ridges (palatal rugæ) lie opposite the canine and incisor teeth (fig. 409, p. 262). The shape of the palate varies much with the individual, especially as regards the degree of vaulting in the posterior part.

Palatine Vessels and Nerves.—If the hard palate of a skull be examined, the anterior palatine foramina (incisor foramina) will be found between the maxillary and premaxillary parts of the palate (Plate L, p. 130). There are four openings in the anterior palatine fossa, two of them for the *naso-palatine* nerves and two for the corresponding arteries, structures which descend on the septum of the nose and end in the palate behind the incisor teeth (fig. 409, p. 262). These vessels and nerves should now be sought for; they are of small size.

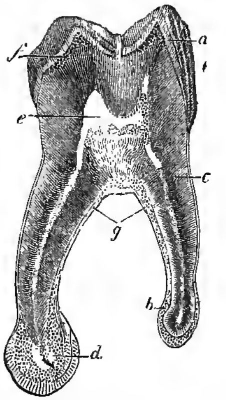
DESCENDING PALATINE ARTERY AND NERVES.—On each side of the macerated palate, between the horizontal processes of the palate and maxilla, open the posterior palatine canals. When the student removes the mucous membrane, with its thick fibrous and glandular submucous coat, from the opening of these canals, the superior or descending palatine artery (from the internal maxillary) and the anterior palatine nerve, from Meckel's ganglion and the superior maxillary division of the Fifth, will be found to emerge and pass forwards in the dense tissue internal to the gums, grooving the bone as they go (fig. 409, p. 262). They supply the hard palate as far forwards as the canine teeth. Branches of the artery also pass back into the soft palate. The external and small posterior palatine nerves which end in the soft palate emerge by small accessory openings behind and external to the posterior palatine canal (fig. 412, p. 267).

The Teeth.—It is not common to find the teeth well preserved in a dissecting-room subject, but what representatives there are should be fully examined and extracted by the student; they are structures with which he may have much to do in after life.

Section of a Tooth.—A vertical section of a tooth *in situ* should be made, preferably an incisor in the lower jaw. When the section is cleaned the following parts may be recognised:

(*a*) The *pulp cavity* (fig. 398, *e*); (*b*) the *dental canal*, containing the inferior dental vessels and nerves: twigs pass from these to the pulp cavities through the apex and canal of the fang; (*c*) the *dentine* surrounding the pulp cavity (fig. 398, *c*); (*d*) the *enamel* covering the dentine of the crown of the tooth (fig. 398, *a*); (*e*) the thin *crusta petrosa* covering the dentine of the fang (fig. 398, *b*); (*f*) the junction of the enamel and crusta petrosa at the *neck* of the tooth (fig. 399); (*g*) the *peridental membrane* surrounding the fang of the tooth and binding it within its socket or alveolus. The peridental membrane serves as periosteum for both the alveolus and crusta petrosa. The inner alveolar wall is the thinner, and yields most easily when a tooth is extracted.

Fig. 398. — Vertical section of molar tooth. (*Carpenter.*)



a. Enamel. *b*, *g*, Crusta petrosa. *c*. Dentine. *d*. Osseous excrescence at end of fang. *e*. Pulp cavity. *f*. Lacunar spaces at outer part of dentine.

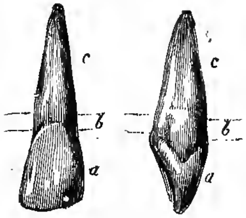
The Incisor Teeth (formula $=\frac{2}{2}$) have chisel-shaped crowns with bulging heels on their lingual aspects. As they are extracted the shape and size of their fangs should be noted (fig. 399). The fangs of the lower teeth are compressed from side to side.

The Canine Teeth (formula $=\frac{1}{1}$) will be found to have their fangs deeply imbedded and difficult to extract—especially the upper. The crowns are more or less pointed (fig. 400).

The BICUSPID OR PREMOLAR TEETH (formula$=\frac{2}{2}$) have crowns made up of two cusps, an outer and inner, the outer being the more prominent. The second upper premolar has commonly two fangs; the rest have only one. The lower fangs are compressed from before backwards.

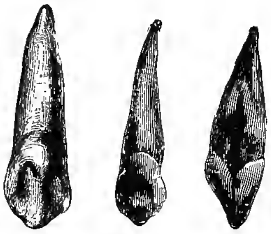
The UPPER MOLAR TEETH (formula$=\frac{3}{3}$) have crowns made up of four cusps, known as the antero-external (A.E. cusp), postero-external (P.E. cusp), antero-internal (A.I. cusp) and postero-internal (P.I. cusp). The P.E. and A.I. cusps are joined by an oblique ridge of enamel. The P.I. cusp is often absent in the third or wisdom tooth, and may be double in the first and second. Each should have three fangs, two outer and one inner, but it is rare among Europeans to find the fangs of the wisdom tooth separate; they are commonly fused and somewhat contorted. It is always worth while, if the wisdom tooth be absent, to chisel into the posterior part of the alveolus to see if it is still imbedded there. It frequently fails to erupt, and may give rise to a widely spread abscess.

FIG. 399.—FRONT AND SIDE VIEW OF A LEFT UPPER CENTRAL INCISOR. (*Tomes.*)



a. Crown. *b.* Neck. *c.* Fang.

FIG. 400.—LINGUAL, LABIAL, AND DISTAL SURFACES OF AN UPPER CANINE. (*Tomes.*)



The LOWER MOLARS lie somewhat in advance of the corresponding upper teeth. Five cusps are commonly present on the crown of the first and second molars; one is posterior, two internal, two external, these being arranged in opposite pairs. They have two fangs, which are compressed from before backwards, and set one in front of the other. The fangs of the wisdom tooth are often malformed. If the wisdom tooth fails to cut, it will be found on the inner aspect of the root of the ascending ramus of the jaw.

The NERVE AND BLOOD SUPPLY OF THE TEETH (see figs. 346, p. 163; 365, p. 189).—The upper teeth are supplied by the three *superior dental nerves*, *anterior* to the incisors, *middle* to the canine and bicuspids, and *posterior* to the molars. They are branches of the superior maxillary division of the Fifth. Arteries derived from the internal maxillary accompany the nerves. The lower teeth are supplied by the inferior dental nerve and artery.

DISSECTION XIX

THE LARYNX

The **Larynx** is situated in the anterior wall of the lower part of the pharynx (fig. 390, p. 233). The student should note the structures which would require division if the larynx were excised. Especially he should examine its connection with the trachea and œsophagus below, and the tongue and hyoid bone above.

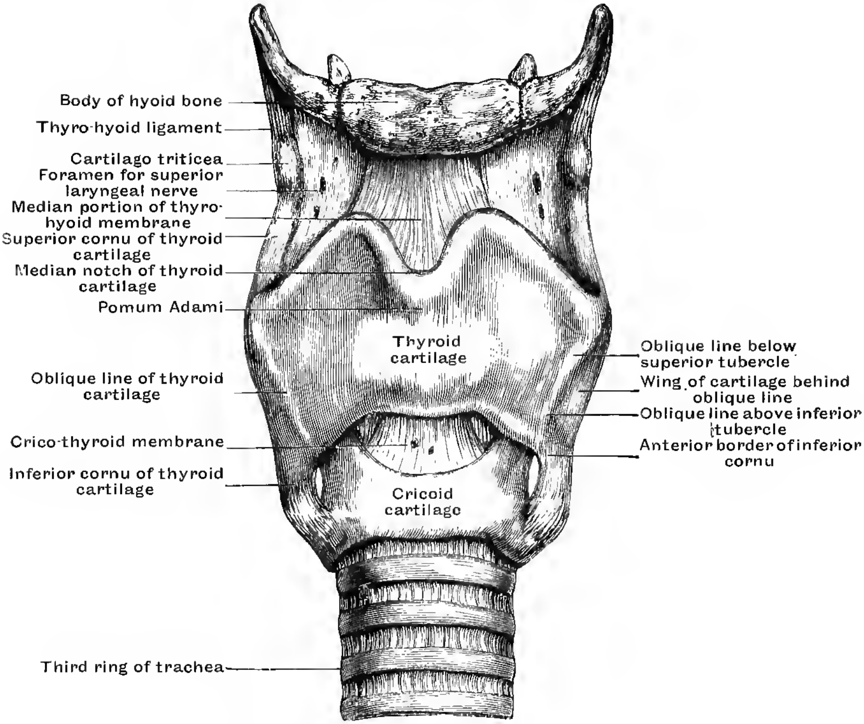
The narrow dimensions of the crico-thyroid space, in which the operation of laryngotomy is performed, should also be investigated. The crico-thyroid muscle and crico-thyroid artery will be found on the membrane closing this space (fig. 289, p. 58).

The Crico-thyroid Muscle will be seen in front between the cricoid and thyroid cartilages, and during life may be distinguished by the finger. Its *origin* is narrow, from the cricoid ring in front; its *insertion* is wide to the posterior half of the lower border, adjacent part of the inner aspect of the thyroid cartilage, and to the inferior cornu of that cartilage. It is supplied by the external laryngeal nerve, a branch of the superior laryngeal (fig. 292, p. 64). When the muscle contracts it elevates the anterior segment of the cricoid cartilage, tilting backwards the posterior segment with the arytenoid cartilages which are situated on its upper margin. In this way it tightens the vocal cords.

The **Thyroid Cartilage** (fig. 401) is formed of two lateral quadrate plates, which are united at their anterior margins and give rise in the male to that angular prominence—the Pomum Adami. The posterior inferior angle of each plate is produced into a cornu, by which the thyroid cartilage is hinged to the cricoid cartilage. The *inferior cornua* of the thyroid rest on the lateral oval facets of the cricoid; a capsular ligament containing a synovial cavity binds the cornu to the cricoid facet.

The *superior cornua* project upwards from the postero-superior angles of the plates, and are fixed by the lateral thyro-hyoid ligaments to the tips of the great horns of the hyoid. The upper margin is united to the hyoid by the thyro-hyoid membrane, which is perforated by the superior laryngeal vessels and nerves. The median part of the membrane (fig. 401) is thick and attached to the postero-superior border of the body of the hyoid. The upper border of the thyroid cartilage is everted in front, and a deep median notch separates the upper borders of the two plates. In the lateral thyro-hyoid ligament a nodule of cartilage may be present.

FIG. 401.—FRONT VIEW OF THE CARTILAGES OF THE LARYNX. (*Modified by Hensman, from Bourgery and Jacob.*)


Body of hyoid bone
Thyro-hyoid ligament
Cartilago triticea
Foramen for superior laryngeal nerve
Median portion of thyro-hyoid membrane
Superior cornu of thyroid cartilage
Median notch of thyroid cartilage
Pomum Adami
Thyroid cartilage
Oblique line of thyroid cartilage
Crico-thyroid membrane
Inferior cornu of thyroid cartilage
Cricoid cartilage
Third ring of trachea
Oblique line below superior tubercle
Wing of cartilage behind oblique line
Oblique line above inferior tubercle
Anterior border of inferior cornu

On the OUTER SURFACE of each thyroid plate (fig. 401) should be noted: (*a*) An *oblique ridge* or line crossing the cartilage from the neighbourhood of the postero-superior angle towards the middle of the lower border. To the ridge the thyro-hyoid and sterno-thyroid muscles are attached. (*b*) The area of origin of the *inferior constrictor* of the pharynx on the outer surface behind the oblique line; this muscle also arises from the cricoid cartilage. (*c*) Fibres of the *inferior constrictor stylo-* and *palato-pharyngeus*, attached to the posterior border of the thyroid cartilage.

The thyroid cartilage is larger in the male, the sexual increase taking place at puberty. Calcareous salts begin to be deposited in it about the thirtieth year, and in old people it can only be cut by a saw or bone forceps.

FUNCTIONS.—It has three main functions: (1) To protect and give attachment to the vocal cords and thyro-arytenoid muscles (figs. 403, 404); (2) to give attachment to the muscles which elevate and depress the larynx; (3) to give origin to the inferior constrictor of the pharynx.

All the muscles are now to be cleared away from the outer surface, posterior and inferior borders of the thyroid cartilage.

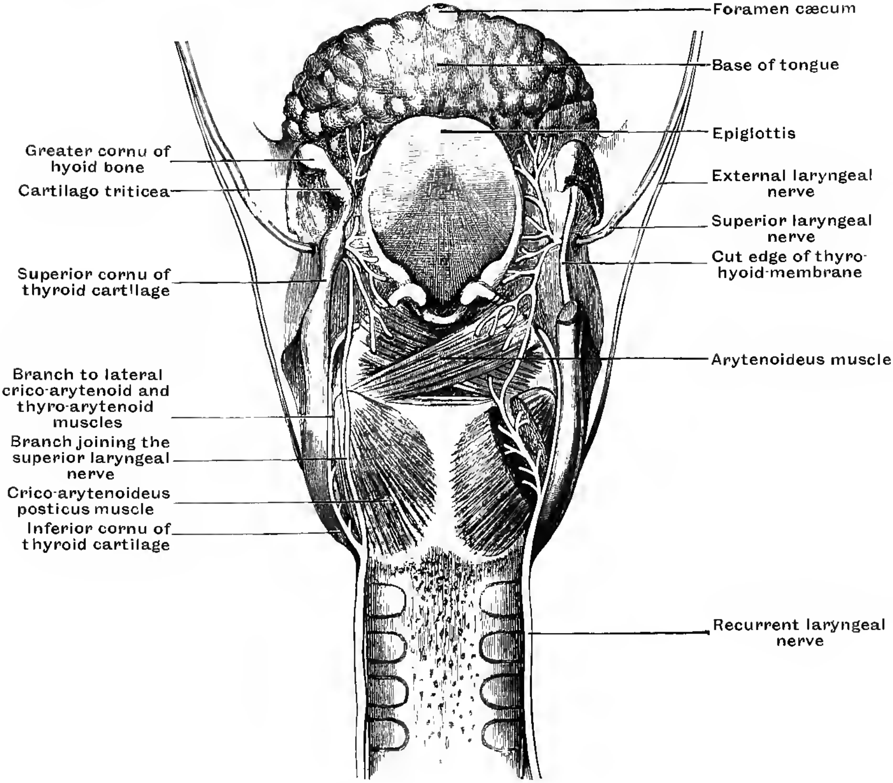
The postero-superior part of each lateral thyroid plate will now be seen to project backwards in the lateral wall of the pharynx and form the outer boundary of the pyriform fossa (fig. 390, p. 233).

DISSECTION.—To expose the structures which lie beneath the thyroid cartilage, the right lateral plate is to be removed by introducing the handle of the knife beneath its posterior border and separating all the structures from its deep surface. The plate is then divided at the anterior angle by means of bone forceps.

Nerves of the Larynx.—The INFERIOR or RECURRENT LARYNGEAL NERVE (fig. 402) has been seen arising from the vagus and turning upwards to the larynx, round the aorta on the left side and round the subclavian on the right. It will now be found in the recess between the œsophagus and trachea, to both of which it supplies branches. Passing behind the inferior horn of the thyroid and beneath the origin of the inferior constrictor, it enters the larynx and supplies all the intra-laryngeal muscles. On the posterior surface of the cricoid cartilage, it communicates with the superior laryngeal nerve (fig. 402). It supplies sensory fibres to the mucous membrane of the trachea.

The SUPERIOR LARYNGEAL NERVE (fig. 402) springs from the trunk ganglion of the vagus, and reaches the outer surface of the thyro-hyoid membrane by passing forwards between the internal carotid artery and constrictor muscles of the pharynx. Piercing the thyro-hyoid membrane, it is distributed to the mucous membrane within the larynx, and to the structures bounding its aperture above. It gives off the external laryngeal nerve to the crico-thyroid (fig. 402).

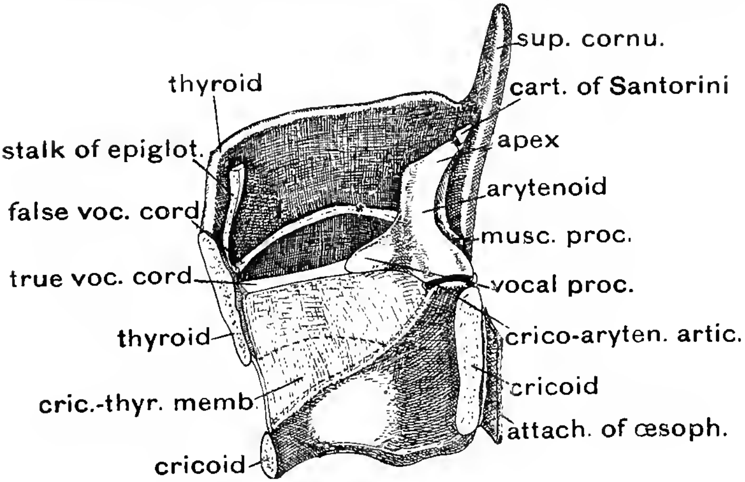
FIG. 402.—NERVES OF THE LARYNX. (POSTERIOR VIEW.) (*From Morris's 'Anatomy.'*)


Foramen cæcum
Base of tongue
Epiglottis
Greater cornu of hyoid bone
Cartilago triticea
External laryngeal nerve
Superior laryngeal nerve
Cut edge of thyro-hyoid membrane
Superior cornu of thyroid cartilage
Arytenoideus muscle
Branch to lateral crico-arytenoid and thyro-arytenoid muscles
Branch joining the superior laryngeal nerve
Crico-arytenoideus posticus muscle
Inferior cornu of thyroid cartilage
Recurrent laryngeal nerve

The LARYNGEAL VESSELS accompany the nerves. The *superior laryngeal* is a branch of the superior thyroid; the *inferior*, a branch of the inferior thyroid artery. Lymphatic vessels accompany the veins, and end in the deep cervical glands along the internal jugular vein. A lymphatic gland receiving vessels from the larynx, normally of minute size, may be found on the thyro-hyoid membrane.

The **Arytenoid Cartilages.**—As the greater number of the muscles of the larynx act on the two arytenoid cartilages, and through them on the vocal cords, it is necessary to form a mental picture of the cartilages before proceeding to examine the muscles. As may be seen from fig. 403, the arytenoid cartilage is a three-sided pyramid, with its apex implanted in the posterior extremity of the aryteno-epiglottic fold. The inter-arytenoid fold of mucous membrane unites the apices of the two arytenoid cartilages. Of its three surfaces one is internal, one posterior, and the other antero-external. Its base rests on an oval articular facet on the upper border of the quadrate plate of the cricoid. At its anterior angle, the base is produced to form the *vocal process* for the attachment of the true vocal cord (fig. 403). Its outer angle is produced to form the *muscular process* on which the crico-arytenoideus lateralis and crico-arytenoideus posticus are inserted. The long axis of the articular facet of the arytenoid crosses at right angles the long axis of the facet on the cricoid. The arytenoid is bound to the cricoid by a capsular ligament. A thin ligament also descends from the apex of the arytenoid to the cricoid. The joint is lined by a synovial membrane. The arytenoid may rotate, glide forwards and backwards, or from side to side, on the transverse oval facet on the upper border of the cricoid.

Fig. 403.—The articulation and connections of the right arytenoid cartilage.

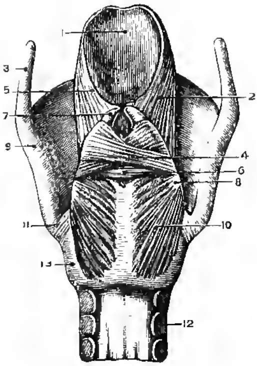


Muscles of the Larynx.—The following are the muscles on each side of the larynx :

(1) Crico-thyroid (see p. 249).
(2) Crico-arytenoideus lateralis.
(3) Crico-arytenoideus posticus.
(4) Arytenoideus.
(5) Thyro-arytenoideus.

The CRICO-ARYTENOIDEUS LATERALIS (fig. 405, 16) is seen beneath the postero-inferior part of the lateral thyroid plate. It arises from the upper border of the cricoid cartilage and lies on the outer surface of the crico-thyroid membrane. Its fibres, passing backwards and upwards, end on the *muscular process* of the arytenoid cartilage (fig. 405, 16).

FIG. 404.—THE MUSCLES OF THE LARYNX VIEWED FROM BEHIND. (*Sappey.*)



1. Epiglottis. 2. Aryteno-epiglottideus. 3. Superior cornu of thyroid. 4. Oblique fibres of arytenoideus. 5. Aryteno-epiglottidean fold. 6. Deep fibres of arytenoideus. 7. Corniculum laryngis or cartilage of Santorini. 8. Muscular angle of arytenoid. 9. Thyroid cartilage. 10. Crico-arytenoideus posticus. 11. Articulation of cricoid with thyroid. 12. Trachea. 13. Cricoid cartilage.

The CRICO-ARYTENOIDEUS POSTICUS (fig. 404, 10) arises from the œsophageal or posterior surface of the quadrate plate of the cricoid. To examine this surface the mucous membrane has to be removed ; the surface will be found to be divided into a right and left half by a vertical median ridge. From the ridge the muscular fibres of the œsophagus arise by a membranous sheet (fig. 403). The median ridge separates the origins of the posterior crico-arytenoid muscles. The fibres pass transversely and obliquely to the muscular process of the arytenoid. It will be observed to be the opponent of the lateral crico-arytenoid muscle. While the posterior muscle retracts the muscular process and thus turns the vocal process and cord outwards, opening the glottis, the lateral muscle advances the muscular process and approximates the vocal cords, thus closing the glottis.

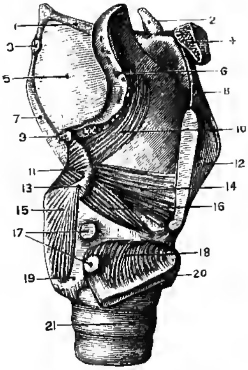
The ARYTENOIDEUS (fig. 404, 4, 6) is mainly composed of fibres which pass transversely from the posterior surface of one arytenoid cartilage to the posterior surface of the other. The *superficial* fibres are arranged obliquely, passing from the base of one cartilage towards the apex of the other, some of the fibres being prolonged within the aryteno-epiglottic folds. These prolonged fibres form the muscle known as the aryteno-epiglottidean (fig. 405, 10).

The arytenoideus approximates the arytenoid cartilages, and thus assists in shutting the upper aperture of the larynx during swallowing, and also approximates the bases of the cartilages and the vocal cords.

The Thyro-arytenoideus (fig. 405, 14) is the chief muscle of the vocal cords. The fibres arise in front from the angle of the thyroid cartilage and pass backwards beneath the ala of the thyroid to the antero-external surface and vocal process of the arytenoid cartilage. The muscle arises external to the attachment of the vocal cord in the angle of the thyroid, and covers the cord as it passes backwards (fig. 403). The more *superficial fibres* are seen to sweep upwards and terminate in and below the aryteno-epiglottic folds. As the *fibres ending on the arytenoid* cartilage are cleared away, *deeper* ones will be seen to adhere to and end in the vocal cord and process. It will be seen that by its three parts (vocal, arytenoid and epiglottidean) the muscle may act on (1) the vocal cords; (2) the arytenoid cartilages; (3) the aryteno-epiglottic folds.

When the muscle contracts, the arytenoid cartilage glides forwards on the oval facet on the upper border of the cricoid. The deeper fibres end in and modify the tension of the vocal cords; the superficial fibres which sweep upwards compress the ventricle of the larynx. The two thyro-arytenoid muscles, contracting with the arytenoid, act as a sphincter of the larynx. (See fig. 282, p. 44.)

Fig. 405.—The muscles of the larynx viewed on removal of the greater part of the right half of the thyroid cartilage. The lower part of the cartilage is thrown down. (*Sappey.*)



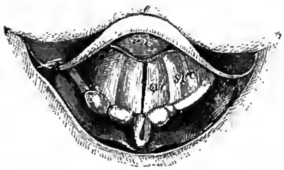
1. Great cornu of hyoid. 2. Lesser cornu. 3. Cartilago triticea in thyro-hyoid ligament. 4. Body of hyoid. 5. Thyro-hyoid membrane. 6. Epiglottis. 7. Superior cornu of thyroid. 8. Front of thyro-hyoid membrane. 9. Corniculum laryngis. 10. Aryteno-epiglottideus. 11. Arytenoideus. 12. Thyroid. 13. Muscular angle of arytenoid. 14. Thyro-arytenoideus. 15. Crico-arytenoideus posticus. 16. Crico-arytenoideus lateralis. 17. Articulation between inferior cornu of thyroid and cricoid (laid open). 18. Crico-thyroid (turned down). 19. Cricoid. 20. Lower part of right ala of thyroid (turned down). 21. Trachea.

The Crico-thyroid Membrane (fig. 401) fills the space between the cricoid and thyroid cartilages in front. Its median part is thick and stretches between the adjacent borders of the two cartilages. The lateral parts, on the other hand, while attached to the upper border of the cricoid cartilage, pass upwards beneath the alæ of the thyroid and beneath the lateral crico-arytenoid muscles to become continuous with the true vocal cords (fig. 403).

The Upper Aperture of the Larynx and Parts seen within.—Before laying the larynx open the student should examine the upper aperture from above and distinguish the points which are revealed on examination by the laryngoscope. (See fig. 406.) These points are:

(*a*) The epiglottis (*e*) and the aryteno-epiglottic folds passing backwards from it. The apices of the arytenoid cartilages, capped by the cartilages of Santorini, are seen to project within the folds behind. A thickening in the fold at each side marks the cartilage of Wrisberg (fig. 407, 10).

FIG. 406.—LARYNGOSCOPIC VIEW OF THE LARYNX FROM ABOVE DURING THE EMISSION OF A HIGH NOTE. (*Czermak.*)



e. Epiglottis. *cu*. Cushion of the epiglottis. *ivc*. True vocal cord. *svc*. False vocal cord.

(*b*) The cushion of the epiglottis (fig. 406, *cu*) is seen as a rounded elevation between the anterior terminations of the aryteno-epiglottic folds. In deglutition the folds and cushion meet and close the upper aperture.

(*c*) Within the upper aperture are seen two lateral folds—the false vocal cords (*s.v.c.*)—passing from back to front.

(*d*) Between the false vocal cords, the paler and more sharply cut true vocal cords are seen (*i.v.c.*). The *glottis* is the aperture between the true vocal cords and processes.

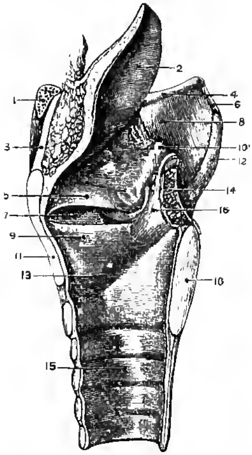
(*e*) With a good light the bifurcation of the trachea can be made out.

The **Cricoid Cartilage** is united with the first ring of the trachea by membrane. Its anterior segment is narrow and ring-like; its posterior segment forms a quadrate plate. Two oval synovial facets on its upper border carry the arytenoid cartilages. On each side are the facets on which the thyroid cartilage is hinged by its inferior cornua. Within, the cricoid cartilage is lined by ciliated respiratory mucous membrane and submucous tissue.

All the Cartilages of the Larynx have now been examined. Three of these are single, viz.—the thyroid, cricoid, and epiglottis; three are paired, viz.—the arytenoid, corniculæ laryngis (cartilages of Santorini), cuneiform (cartilages of Wrisberg). The last named may be absent.

Interior of the Larynx.—The larynx is now to be laid open by dividing it with saw and knife along the median line into a right and left half. The true vocal cords project within the cavity and divide it into a superior and an inferior part (fig. 407, 9). The inferior part or compartment is merely a continuation upwards of the tracheal tract within the cricoid cartilage. The mucous membrane lines the cricoid cartilage and crico-thyroid membrane (fig. 407). The true vocal cords are bevelled on their lower surfaces and slant towards the glottis, at which the inferior compartment ends. An incision through the crico-thyroid space and membrane opens the lower compartment of the larynx. The false vocal cords project within the upper compartment of the larynx; under the false vocal cords the mucous membrane passes upwards into a recess—the ventricle of the larynx (fig. 407, 7). If the right and left ventricles are distended, as they can be in expiration, the false vocal cords meet and form a valve which prevents further egress of air, in the same way as the valves of the aorta close when blood regurgitates within the sinuses of Valsalva. The mucous membrane within the ventricles is ciliated, and in its submucous tissue are many glands the secretion of which lubricates the true vocal cords. At its apex the ventricle is produced to form the *saccule* of the larynx.

Fig. 407.—Vertical section of larynx showing its interior. (*Sappey.*)



1. Body of hyoid bone. 2. Epiglottis. 3. Front of thyro-hyoid membrane. 4. Great cornu of hyoid. 5. False vocal cord. 6. Thyro-hyoid ligament. 7. Ventricle of larynx. 8. Thyro-hyoid membrane. 9. True vocal cord. 10. Aryteno-epiglottidean fold and cartilage of Wrisberg. 11. Thyroid cartilage. 12. Superior cornu of thyroid. 13. Crico-thyroid membrane. 14. Arytenoideus muscle. 15. Trachea. 16. Arytenoid cartilage. 18. Cricoid cartilage.

The **True Vocal Cords** (fig. 407, 9) have a sharply defined inner margin. Their upper and lower surfaces are bevelled, the upper being the flatter; it may be concave. The epithelium which covers them is stratified like that of the skin, and the mucous membrane is thin and closely adherent to the yellow elastic inferior thyro-arytenoid ligament which forms the basis of each cord (fig. 403). The mucous membrane covering the false vocal cord, on the other hand, is ciliated and loosely bound down by a lax submucous tissue. The true vocal cords are 10 mm. long in women and 15 mm. long in men. The inferior thyro-arytenoid ligaments which form the bases of the cords are continuous with the lateral crico-thyroid membrane; in front they are attached in the angle of the thyroid cartilage halfway between its upper and lower borders. Behind they end in the vocal process of the arytenoid cartilages, which are nearly half the length of the cords (fig. 403). The position and tension of the vocal cords are regulated by the muscles of the larynx.

The FALSE VOCAL CORDS overhang the ventricles of the larynx. The superior thyro-arytenoid ligaments, composed of loose fibrous tissue, form their bases. These ligaments are attached in front to the angle of the thyroid above the origin of the true vocal cords, and behind to the anterior surface of the arytenoid cartilages (fig. 403).

The **Glottis** or **Rima Glottidis** is the opening between the vocal cords and processes. The anterior two-thirds of the space is bounded by the two vocal cords (the vocal part of the glottis), while the vocal processes bound the posterior third (the respiratory part). The length of the glottis in the male is, on an average, about 23 mm. (nearly an inch) and in the female about 17 mm.

The **Epiglottis** is now seen in section (fig. 407). It is composed of yellow fibro-cartilage, and is therefore both flexible and resistent. By its narrow stalk, which becomes purely fibrous at its lower end, it is attached to the inner angle of the thyroid cartilage above the origin of the true vocal cords (fig. 403); at each side of its stalk end the false vocal cords. As it passes upwards it lies in the angle of the thyroid cartilage and thyro-hyoid membrane, to which it is bound by much yellow fibrous tissue. It passes behind the body of the hyoid bone, and is bound to the bone by loose fibrous tissue. Above it expands and is attached to the tongue and upper aperture of the larynx (p. 245). The glands situated in the submucous tissue produce pits on the cartilage of the epiglottis.

DISSECTION XX

THE NASAL CAVITIES

The **Choanæ** or **Posterior Nares.**—Before commencing the dissection of the nasal cavities, the student should examine the posterior nares and the parts seen within them (fig. 393, p. 237). By a proper arrangement of mirrors the expert laryngologist can examine these parts during life. The size of the posterior nares should be noted. Each is about 1¼ inch high and ¾ inch broad; in cases of persistent hæmorrhage from the nose, the surgeon may find it necessary to plug them.

Parts seen through each of the Posterior Nares (fig. 393, p. 237).

(*a*) The posterior end of the inferior turbinate process, covered with a thick mucous membrane and a pulpy layer of cavernous submucous tissue.

(*b*) The posterior extremity of the middle turbinate process, almost in contact with the nasal septum.

(*c*) The posterior extremities of the middle and inferior meatuses. The inferior is much larger than the middle.

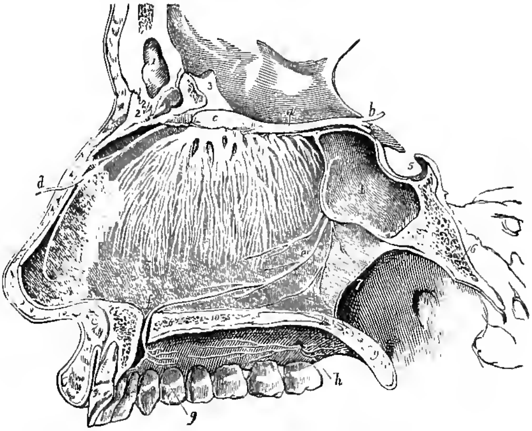
Catheterisation of the Eustachian Tube.—The student should bend the end of a probe so as to resemble a miniature catheter. The Eustachian catheter is passed from the anterior nares along the inferior meatus until it passes over the soft palate. Then the tip is turned downwards and drawn forwards until it is hooked on the soft palate. By rotating the probe a half turn when in this position, the tip will be brought to the mouth of the Eustachian tube. The tube opens half an inch behind, and on a level with the inferior turbinate process.

The Anterior Nares and external nose have already been examined (p. 132). The anterior nares are on a level with the nasal floor (fig. 411). With the aid of a speculum and artificial light the beak of the middle turbinate process can be distinguished, and the anterior parts of the middle and inferior turbinate processes.

Septum of the Nose (fig. 408).—To examine the septum of the nose the facial part of the skull has to be split into a right and left half, the saw-cut being made along the base of the skull, so as to include the septum on the right half of the part. The crista galli is continuous with, and indicates exactly the position of the nasal septum, which, however, is seldom quite in the middle line, but bent to one side or the other.

The Mucous Membrane of the septum is bound down by a submucous tissue containing a rich network of vessels. The chief vessels are the naso-palatine. The naso-palatine artery is derived from the spheno-palatine (fig. 409), a branch of the internal maxillary. The artery crosses the roof of the nose from the spheno-palatine foramen to the posterior part of the septum, on which it proceeds obliquely downwards, giving off branches as it descends, and reaches the anterior palatine foramen in the floor of the nose. Through the anterior palatine foramen (incisive canal) the artery reaches the roof of the mouth, where it ends in the mucous membrane behind the incisor teeth (fig. 409). On the septum it anastomoses with branches from the *anterior ethmoidal* (a branch of the ophthalmic) and the *septal* artery, a branch from the superior coronary artery.

Fig. 408.—Olfactory nerves, with their distribution on the septum nasi. The nares have been divided by a longitudinal section made immediately to the left of the septum, the right naris being preserved entire. (*Wilson.*)



1. Frontal sinus. 2. Nasal bone. 3. Crista galli. 4. Sphenoidal sinus of left side. 5. Sella turcica. 6. Basilar process of sphenoid and occipital bone. 7. Posterior opening of the right naris. 8. Opening of the Eustachian tube. 9. Soft palate. 10. Cut surface of the hard palate. *a.* Olfactory tract. *b.* Its three roots of origin. *c.* Its bulb, from which the filaments are seen to proceed which spread out in the substance of the pituitary membrane. *d.* Nasal branch of the ophthalmic nerve. *e.* Naso-palatine nerve, distributing twigs to the mucous membrane of the septum nasi in its course to (*f*) the anterior palatine foramen. *g.* Branches of the naso-palatine nerve to the palate. *h.* Anterior and posterior palatine nerves. *i.* Septum nasi.

The source of persistent hæmorrhage from the nose is frequently a branch of the septal artery.

The Naso-palatine Nerve (fig. 408, *e*) comes from Meckel's ganglion and has the same course and distribution as the artery. The nerve reaches the palate in a separate bony compartment.

Olfactory Part of the Mucous Membrane.—On the upper third of the septum the mucous membrane is supplied by olfactory nerves (fig. 408). In the recent state it has a yellowish tint. The columnar epithelium which covers it is non-ciliated. Frequently the line of union can be distinguished between the olfactory upper third and respiratory lower two-thirds. The respiratory part is covered by columnar ciliated epithelium and contains mucous glands. A slight elevation in the septum above the opening of the naso-palatine canals marks the vestige of the *organ of Jacobson.* The organ is shielded by a slight process of cartilage, which encloses a minute detached area of the olfactory mucous membrane.

The Skeletal Basis of the Septum.—When the mucous membrane is stripped from the bone and cartilage, the septum is seen to be made up of three parts :

(*a*) The vomer.
(*b*) The vertical plate of the ethmoid.
(*c*) The septal cartilage.

The septal cartilage is always more or less bent to one side. The bend, when seen through the anterior nares, appears like a tumour of the septum. The septum, at its circumference, is completed by the following processes (see fig. 409) :

(1) The crest of the nasal bones; (2) the spine of the frontal; (3) the crest and rostrum of the sphenoid; (4) the nasal spine and crest of the superior maxillary and palate bones. The septum is now to be cut completely away.

The Roof of the Nose.—As seen in the section of the lateral wall of the nose, the roof is formed of three parts (fig. 409) :

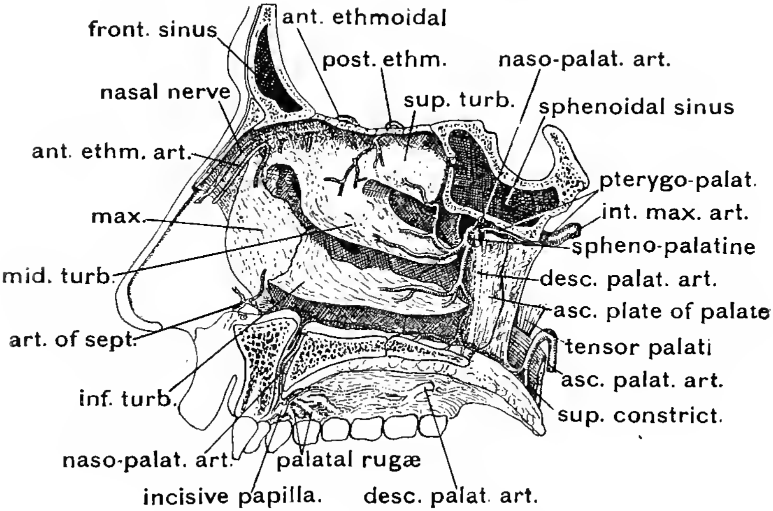
(*a*) A *horizontal middle* part, composed of the cribriform plate of the ethmoid; through it the olfactory nerves reach the nasal cavity from the olfactory bulb (fig. 408), and through it also the nasal lymphatics communicate with spaces beneath the membrane of the brain.

(*b*) An *anterior sloping* part, formed by the nasal bones, nasal spine of frontal, and nasal cartilages.

(*c*) A *posterior sloping* part formed by the body of the sphenoid; on this part of the roof open the sphenoidal sinuses.

The SPHENOIDAL SINUS (fig. 409) was exposed by the mesial section. It distends the body of the sphenoid and is of large size. The ciliated mucous membrane of the nose passes within the sinus by the opening in the posterior part of the nasal roof and lines the cavity. On the roof of the two sinuses rest the pituitary body and cavernous sinuses (fig. 319, p. 125). The right and left cavities are separated by a mesial septum.

FIG. 409.—THE BONES AND ARTERIES OF THE LATERAL WALL OF THE RIGHT NASAL CAVITY AND OF THE PALATE.



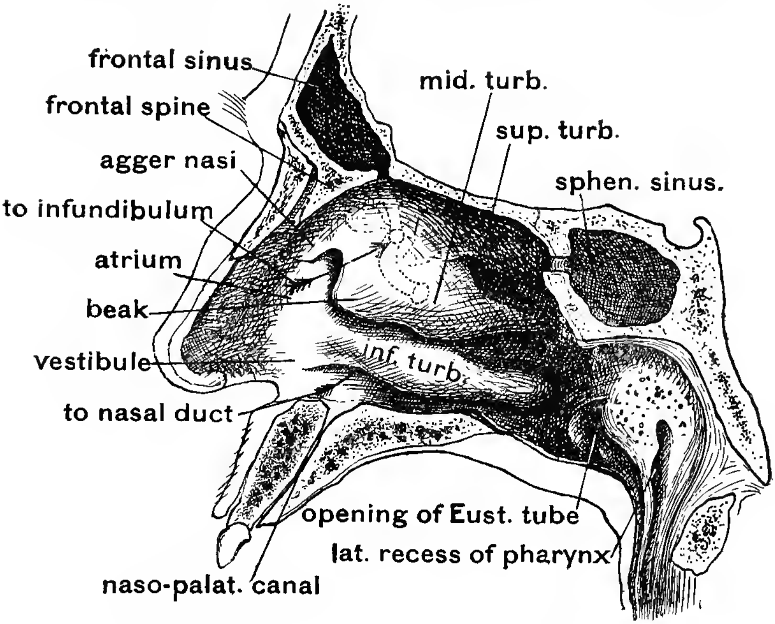
In catarrh of the nose, the inflammation may spread within this great sinus.

NASAL NERVE AND ANTERIOR ETHMOIDAL ARTERY.—The nasal nerve and anterior ethmoidal artery will be found on the anterior sloping part of the nasal roof (figs. 408 and 409). They groove the under surface of the nasal bones. Their origin has already been seen within the orbit (p. 160), and their course over the cribriform plate. They terminate (1) on the antero-superior part of the septum; (2) on the lateral wall of the nose; (3) on the skin and tissue over the cartilaginous part of the outer nose (fig. 304, p. 97).

The Lateral Wall of the Nose. THE MUCOUS MEMBRANE

OF THE LATERAL WALL OF THE NOSE (fig. 410).—Three distinct turbinate processes throw the outer or lateral wall of the nose into folds; over the upper and a narrow part of the middle turbinate processes the mucous membrane is olfactory and non-ciliated; the fibrous-like strands of the olfactory nerve commence in it. On the prominent convexity of the lower part of the middle turbinate and over the inferior turbinate, the epithelium is ciliated and respiratory in function. The mucous membrane covering the inferior turbinate process, especially over the posterior part of the process, is extremely thick, pulpy, and covers a cavernous dilatable submucous tissue. Mucous glands abound in the respiratory part of the mucous membrane.

FIG. 410.—THE LATERAL WALL OF THE RIGHT NASAL CAVITY. (*K. F. Lund.*)



VESTIBULE AND ATRIUM OF THE NASAL CAVITY.—As the air is inspired it enters at the anterior nares and fills the *vestibule*—that part of the nasal cavity within the cartilaginous part of the nose (fig. 410). Long hairs (vibrissæ) project at the entrance of the vestibule and arrest incoming floating particles. Between the vestibule and the upper part of the nasal cavity there is an intermediate space known as the *atrium*. It is greatest in extent in front of the middle meatus (fig. 410). On its lateral wall, a rudiment of the naso-turbinal (agger nasi) can frequently be recognised (fig. 410).

SUPERIOR TURBINATE PROCESS AND MEATUS.—The superior turbinate process lies under the roof in the upper and posterior part of the nasal cavity (fig. 410). In the mucous membrane covering it will be found the olfactory nerves and small vascular twigs of the spheno-palatine vessels (fig. 409). When the process is cut away, the superior meatus is exposed. Into it open the *posterior ethmoidal cell or cells* which distend the posterior part of the lateral mass of the ethmoid. Like all the sinuses which open in the nasal cavity, the ethmoidal are lined with a ciliated mucous membrane.

The MIDDLE TURBINATE PROCESS ends in front in a prominent angular *beak*, a valuable guide to the infundibulum, the duct of the frontal sinus (fig. 410). As the mucous membrane is stripped off the thin bony shell of the process, lateral or posterior nasal branches of the descending palatine vessels and lateral branches from the nasal nerve and from Meckel's ganglion will be seen (fig. 412). In front, the attached part of the process is continuous with a slight elevation on the lateral nasal wall—the *agger nasi* or *naso-turbinal* (fig. 410). The middle meatus opens anteriorly into the atrium.

Middle Meatus.—When the middle turbinate process is cut away, the following parts, shown in fig. 411, are exposed :

(1) A semilunar groove, such as might be formed by a thumb-nail, with a sharp prominent convex lower border—the *hiatus semilunaris.*

(2) Into the anterior and upper extremity of the hiatus opens the *infundibulum*—the canal of the frontal sinus (fig. 411, 3).

(3) At its posterior end opens the *maxillary sinus* (Antrum of Highmore). The sinus may become a receptaculum for pus which escapes from the frontal sinus, in cases of catarrh of that chamber, owing to the hiatus semilunaris acting as a gutter or drain.

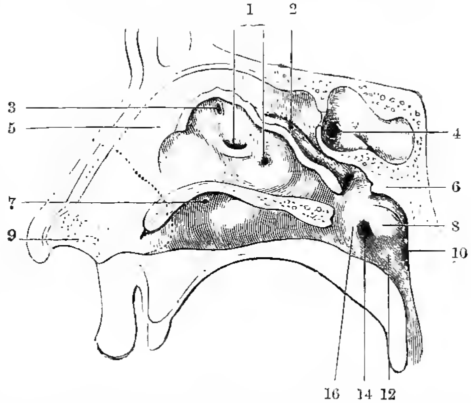
(4) Above the hiatus is a rounded elevation, the *bulla ethmoidalis.*

(5) On or above the bulla is another opening, that of the

middle ethmoidal sinus. This should be opened up and its mucous lining examined.

The **Frontal Sinus** (fig. 410).—Through the infundibulum catarrhal conditions may spread from the nasal cavity to the frontal sinus. The infundibulum is narrow and may become occluded by a swelling of its lining membrane. It is short (about three-quarters of an inch), passes upwards and forwards, and in some cases could be catheterized from the anterior nares. The frontal sinuses, one on each side, lie under the glabella and supraciliary ridges and above the supra-orbital ridges. The septum which separates them is seldom in the middle line. They vary much in size; they may be absent or very extensive, but as a rule they are triangular in shape, about one inch in width, and three-quarters of an inch from before backwards at their lowest part. Into the infundibulum will be seen to open two other small sinuses, the *anterior ethmoidal* and *lachrymo-ethmoidal,* both being situated beneath the lachrymal bone and on each side of the infundibulum. The sharp lower border of the hiatus semilunaris is formed by the uncinate process of the lateral mass of the ethmoid.

FIG. 411.—OUTER WALL OF NASAL CAVITY AND NASO-PHARYNX. (*Anderson after Merkel.*)



1. Antral openings in middle meatus. 2. Middle turbinate bone (cut). 3. Orifice of infundibulum. 4. Sphenoidal sinus. 5. Atrium. 6. Sphenoid bone. 7. Orifice of nasal duct beneath cut inferior turbinated bone. 8. Tubal prominence. 9. Vestibule. 10. Lateral recess or fossa of Rosenmüller. 12. Ridge corresponding to salpingo-pharyngeus. 14. Eustachian tube. 16. Ridge corresponding to levator palati.

The **Maxillary Sinus** or **Antrum of Highmore.**—As a rule its opening lies at the posterior end of the hiatus semilunaris (fig. 411, 1). The foramen is situated on the inner wall of the sinus, and nearer its anterior than its posterior extremity. The maxillary sinus, which is pyramidal in shape, has already been examined from the face (p. 140); now a part of the nasal wall should be removed and a further examination made. The orbital floor bounds the sinus above; the facial and zygomatic surfaces of the superior maxillary bone form its anterior and posterior walls; the lateral wall of the nose forms its base, while its apex projects within the malar. Its lower margin lies along the alveolus from the canine to the last molar. It is lined by a ciliated mucous membrane. The roots of the premolar and molar teeth frequently give rise to slight projections within it; the superior maxillary nerve and its dental branches tunnel its walls (fig. 346, p. 163).

The **Inferior Turbinate Process** roofs over the tent-shaped inferior meatus (fig. 411). As its greatly thickened mucous membrane is removed, lateral nasal branches of the descending palatine vessels and nerves are seen (fig. 409 and 412). When it is cut away the valvular opening of the nasal duct will be found in the inferior meatus. The opening of the duct is oblique, exactly resembling that of the ureter within the bladder. The ascending process of the inferior turbinate should be cut away and the nasal duct examined. It is three-quarters of an inch long, and gives rise to a projection within the anterior angle of the maxillary sinus.

The FLOOR OF THE NASAL CAVITY is formed of the palatine plate of the superior maxilla and horizontal plate of the palate bone (fig. 409). In its floor in front is the funnel-shaped naso-palatine canal between the maxillary and premaxillary parts of the palate. The floor is covered by a layer of mucous membrane and submucous tissue. In front, branches from the anterior superior dental nerve and superior coronary artery should be looked for.

The **Spheno-maxillary Fossa.**—When the student dissected the zygomatic space, the spheno-maxillary fossa, seen in the floor of the space, was left unexamined. Before proceeding to dissect out the contents of the fossa, he should note its boundaries in a skull and the foramina which open out from it (see figs. 358, p. 181, and fig. 413). The pterygoid process and great wing of the sphenoid bound it behind and above, the superior maxillary in front; it communicates with the orbit through the spheno-maxillary fissure. The foramina opening into it are (fig. 413, p. 268):

(1) The FORAMEN ROTUNDUM, through which the superior maxillary nerve escapes from the skull.

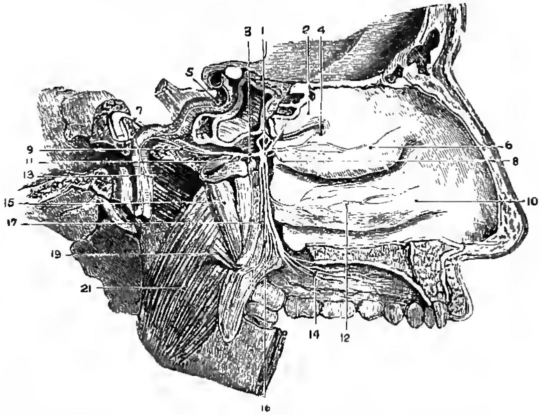
(2) The VIDIAN CANAL in the root of the pterygoid process. The Vidian branch of the internal maxillary artery passes backwards through it; the Vidian nerve joins the spheno-palatine ganglion.

(3) The INFRA-ORBITAL CANAL, into which the superior maxillary nerve passes after traversing the fossa.

(4) The POSTERIOR PALATINE CANAL, through which the posterior palatine nerves and artery reach the palate.

(5) The SPHENO-PALATINE foramen in the upper part of the floor of the fossa; through it, structures within the fossa (the naso-palatine nerve and spheno-palatine artery) pass within the nasal cavities (see fig. 409).

FIG. 412.—MECKEL'S GANGLION AND ITS BRANCHES.
(*From Hirschfeld and Leveillé.*)



1. Spheno-palatine ganglion (Meckel). 2. Superior turbinate bone. 3. Vidian nerve. 4. Nasal branches. 5. Carotid artery in temporal bone. 6. Middle turbinate bone. 7. Greater superficial petrosal nerve joining the facial. 8. Naso-palatine nerve (cut). 9. Carotid branch of Vidian. 10. Inferior turbinate bone. 11. Pharyngeal nerve. 12. Inferior nasal branches. 13. Pterygoideus externus. 14. Anterior or great palatine nerve. 15. Tensor palati. 16. Middle or external palatine nerve. 17. Posterior palatine nerve. 19. Levator palati (cut). 21. Pterygoideus internus.

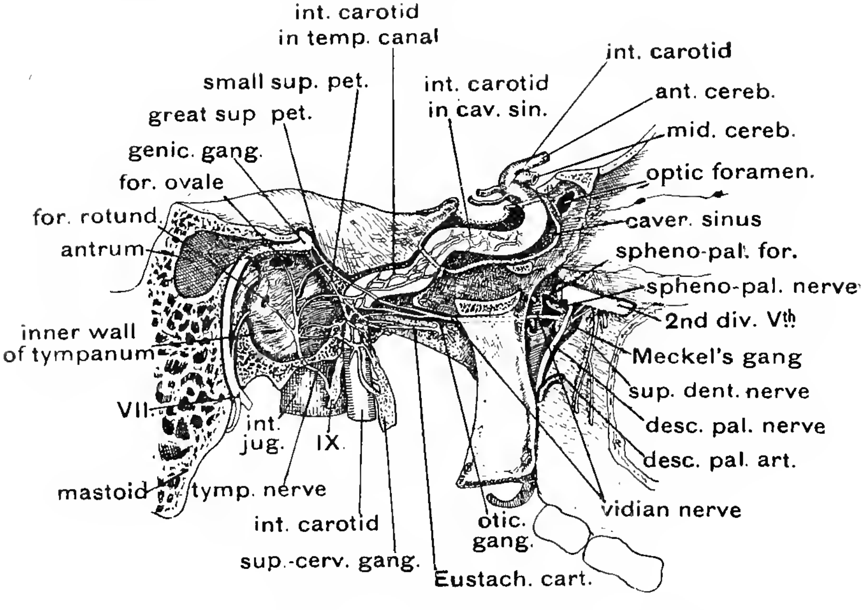
(6) The PTERYGO-PALATINE CANAL, formed between the pterygoid process and palate bone. By it a small artery and nerve pass backwards to the roof of the pharynx (fig. 409).

POSTERIOR DENTAL AND INFRA-ORBITAL ARTERIES.—The internal maxillary artery should be followed within the fossa (see fig. 358, p. 181). Its POSTERIOR DENTAL branch is seen to end in dental canals which open on the zygomatic surface of the superior maxilla. By a section, such as is shown in fig. 413, the spheno-maxillary fossa may be exposed and the

INFRA-ORBITAL branch of the internal maxillary artery followed upwards within the orbit to join the infra-orbital nerve in the infra-orbital canal.

Spheno-palatine or **Meckel's Ganglion** (see figs. 412 and 413).—The student must again turn to the nasal aspect of the part and expose this ganglion on its inner side (fig. 412). The mucous membrane has already been removed from the internal pterygoid plate and from the ascending process of the palate bone, beneath which the posterior palatine nerves descend within their canal. Higher up, at the posterior termination of the middle turbinate process, the naso-palatine and upper nasal nerves and spheno-palatine artery enter by the spheno-palatine foramen. This should be sought out and the thin vertical plate of the palate bone, which forms the inner wall of the spheno-maxillary fossa, removed (see fig. 409, p. 262). The sphenoid above is to be cut away until the superior maxillary nerve is exposed. The spheno-palatine ganglion, about the size of a grape-seed and flat, will be found below the superior maxillary

Fig. 413.—Diagram to show (1) the spheno-maxillary fossa and the nerves contained in it; (2) the petrosal nerves; (3) the inner wall of the tympanum; (4) the intra-cranial course of the internal carotid artery.



nerve, suspended from it by several short nerve cords. If its discovery is found difficult, the student may reach it by following up the descending palatine nerves, which are closely connected with the ganglion. The terminal branches of the internal maxillary artery and the fibro-fatty tissue surrounding the ganglion render a satisfactory dissection of it a delicate matter.

Roots and Branches of the Spheno-palatine Ganglion.—The following nerves connected with the ganglion should then be sought out (fig 413):

(*a*) The two SPHENO-PALATINE ROOTS which connect it with the superior maxillary nerve. Most of the fibres of the roots pass directly to the descending palatine nerves.

(*b*) The DESCENDING or POSTERIOR PALATINE NERVES, which have been already followed to their termination (p. 243).

(*c*) Minute ORBITAL BRANCHES ending in the periosteum on the floor of the orbit through the spheno-maxillary fissure.

(*d*) The NASO-PALATINE and upper NASAL NERVES, passing to the nasal mucous membrane through the spheno-palatine foramen (fig. 412).

(*e*) The small PHARYNGEAL BRANCH, passing backwards in the pterygo-palatine canal to the roof of the pharynx and the tissues over the mouth of the Eustachian tube.

(*f*) The VIDIAN NERVE, reaching the ganglion through the Vidian foramen. Its origins from the facial nerve and carotid plexus of the sympathetic are described in the dissection of the petrous bone (see fig. 413).

Branches from the Third Stage of the Internal Maxillary Artery:

(*a*) The Posterior Superior Dental (see p. 164 and fig. 364).

(*b*) The Infra-orbital (see p. 138 and fig. 364).

(*c*) The Spheno-palatine (see p. 260 and fig. 409).

(*d*) The Descending Palatine (see p. 243 and fig. 409).

(*e*) The Pharyngeal, a small twig which accompanies the pterygo-palatine nerve from Meckel's ganglion (see p. 269 and fig. 409).

(*f*) The Vidian Artery passes backwards in the Vidian canal and ends on the Eustachian tube (fig. 413).

The veins which accompany these arteries terminate in a venous plexus continuous with the network of veins which surrounds the external pterygoid muscle, and communicate with the inferior ophthalmic vein.

DISSECTION XXI

THE EAR AND PETRO-MASTOID REGION

The student has now only a remnant of his part left, but it is a remnant of the very utmost practical importance. So many are the structures in this small part, and so liable are they to disease, that it provides many professional men with life-long work. The organ of hearing is situated within it; through the Eustachian tube diseases reach the middle ear, and from the middle ear may invade the brain; the facial nerve pursues a tortuous course through it; the carotid artery pierces it to reach the cranial cavity; it is liable to be involved in fractures of the skull, and has frequently to be explored by the surgeon. The student will see the necessity for a thorough examination of the part.

A SECTION OF THE TEMPORAL BONE.—While the right temporal bone is reserved for a dissection made step by step, the left side, by a mutual arrangement on the part of the two dissectors, should be divided in the following way:—The saw is entered on the upper edge of the squamous part of the temporal at a point vertically above both the internal and external auditory meatuses, and the section carried vertically downwards, dividing the bone into anterior and posterior parts. The two meatuses, the middle ear and internal ear, are thrown open by the section (see figs. 414 and 415). A similar section of a macerated temporal bone will greatly help the student to understand the sections he has now before him.

Structures seen on Section.—To give the student a correct conception of the parts of the ear and their relationship to each other, he should note the following points on both surfaces of the section he has just made (see figs. 414 and 415):

(1) The *external auditory meatus*.—It is about 1¼ inch long.

(2) The *membrana tympani*, or drum of the ear, which separates the external meatus from the tympanum. The handle of the malleus lies on the drum. Internal to the handle the chorda tympani passes forwards.

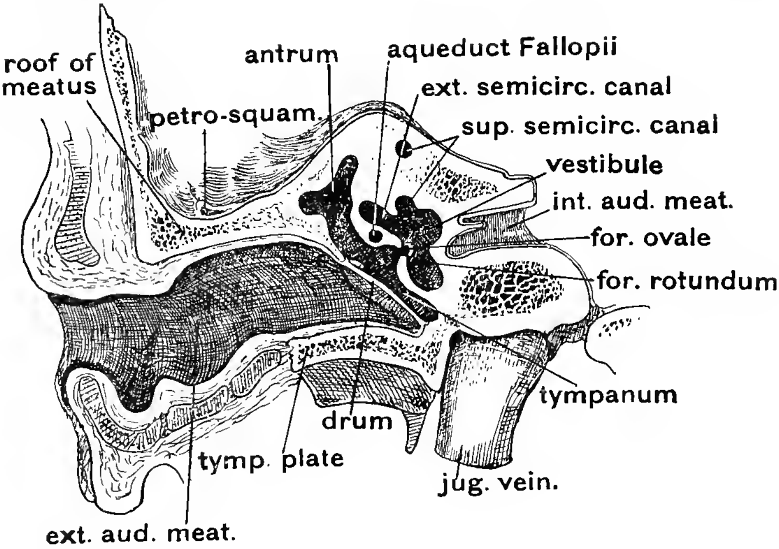
(3) The *tympanum* or middle ear, an extremely narrow cavity which contains the three ear-bones or ossicles.

(4) The *attic*, that part of the tympanum which lies above the level of the drum.

(5) The *antrum of the mastoid*, an air cavity which opens on the *posterior* wall of the attic.

(6) The tympanic end of the *Eustachian tube*, which opens on the *anterior* wall of the tympanum (fig. 415).

Fig. 414.—Transverse vertical section of the right external auditory meatus, tympanum, vestibule, and internal auditory meatus. Looking from before backwards.



(7) The *tegmen tympani*, a thin plate of bone which forms the roof of the tympanum and antrum.

(8) The *tympanic plate* which forms the floor of the tympanum and of the inner part of the external meatus.

(9) The *internal tympanic wall*, a plate of bone which separates the tympanum from the vestibule, the osseous cavity of the internal ear. In the dried state it shows two fenestræ or foramina—the foramen rotundum and the foramen ovale (fig. 414).

(10) The *vestibule*, which contains two membranous sacs, the saccule and utricle. These are part of the membranous

labyrinth. Behind the vestibule are the three semicircular canals; in front of and below it is the cochlea.

(11) The *internal auditory meatus*, about 8 mm. ($\frac{1}{3}$ in). in length. It shows a crest—the crista falciformis (fig. 415).

(12) The *aquæductus Fallopii*, the canal for the facial nerve, is exposed. It is seen on both sides of the section. It commences in the fundus of the internal auditory meatus (fig. 415).

(13) The *carotid canal* in the temporal bone. It transmits the internal carotid artery, and is seen on the anterior half of the section turning inwards at the antero-internal angle of the tympanum (fig. 415).

(14) The *jugular vein* is seen issuing by the jugular foramen in the posterior half of the section (fig. 414).

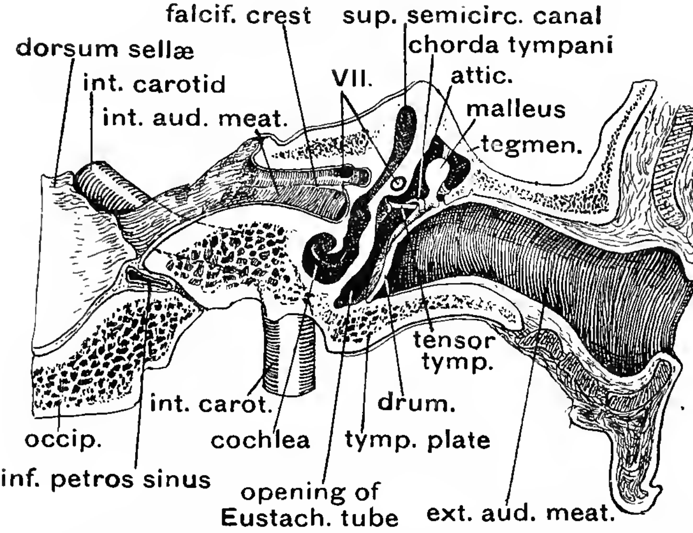
The student should further observe the narrow space occupied by the middle and internal ear; from the fundus of the external meatus to that of the inner is merely a distance of 6 to 8 mm. ($\frac{1}{4}$ to $\frac{1}{3}$ in.).

The **External Auditory Meatus** should now be examined, on both the divided and the undivided sides. The meatus is 30 mm. ($1\frac{1}{4}$ inch) in depth; it is directed inwards and slightly forwards. Its fundus is formed by the membrana tympani, which is set obliquely, so that its outer surface looks outwards, downwards, and forwards. By means of a speculum and mirror it can be examined during life, and it will be observed that a speculum must be flattened from above downwards if it would fit the meatus, which is wider than it is high. The floor is also raised in the middle, the elevation being due to the tympanic plate which forms the inner half of the meatal floor. The inner two-thirds of the roof (fig. 414) are composed of bone; the roofing plate is formed by the squamous part of the temporal bone, and is seldom less than 3 mm. ($\frac{1}{8}$ inch) and rarely more than 8 mm. ($\frac{1}{3}$ inch) in thickness. Hence the surgeon knows that a trephine opening which is more than 8 mm. above the roof of the meatus is likely to expose the cranial cavity.

In childhood the meatus is shorter and the tympanic membrane more easily examined. At birth the tympanic plate is represented merely by a ring of bone which supports the tympanic membrane; it is fully developed by the twentieth year. At birth, too, the bony meatal roof is slightly developed; the fibrous tissue with imbedded irregular hoops of cartilage, which forms the outer half of the floor of the adult meatus, forms nearly the whole floor in the quite young child.

LINING MEMBRANE OF THE MEATUS.—The meatus is lined by skin, which in its outer half contains wax glands and hair roots. The skin is bound to the bony and fibro-cartilaginous walls by dense tissue, sometimes the seat of painful pustules. The nerves ending in it are (fig. 311, p. 107) :

FIG. 415.—THE ANTERIOR HALF OF THE SECTION SHOWN IN FIG. 414. LOOKING FROM BEHIND FORWARDS.



(1) *Auricular* (Arnold's) *branch of the vagus*; it escapes between the external auditory process and mastoid, and enters the meatus from behind.

(2) *Meatal branch of the auriculo-temporal.*

(3) *Branches from the great auricular.*

The MEATAL VESSELS are derived from (fig. 311, p. 107) : (1) The internal maxillary (meatal branch), (2) the superficial temporal (auricular branch), and (3) the posterior auricular (meatal branches).

RELATIONSHIPS OF THE MEATUS.—On the temporal part of the meatal roof rests the third temporo-sphenoidal convolution; behind and above this part of the meatus is the antrum of the mastoid, a cavity which will be examined later (see fig. 416). To reach this cavity, frequently the seat of chronic ear disease, the surgeon opens a route along the postero-superior wall of the meatus. The temporo-maxillary articulation lies below and in front of the meatus and tympanum. The parotid gland is pressed against the outer half of the floor. Parotid abscesses have been known to burst through into the meatus.

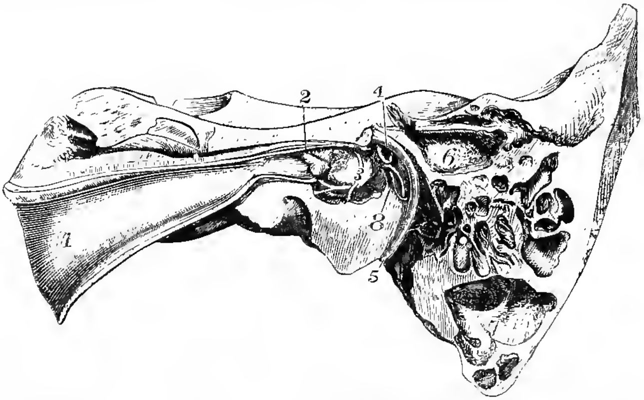
The **Eustachian Tube** connects the cavity of the middle ear or tympanum (see figs. 416 and 424) with the naso-pharynx. Through it the atmospheric pressure is maintained at an equal tension on both sides (tympanic and meatal) of the membrana tympani. Through it, too, inflammatory processes within the nose or pharynx may reach the tympanum. The mucous membrane which lines it is covered by ciliated epithelium.

The PHARYNGEAL MOUTH OF THE TUBE is situated on a level with and behind the inferior turbinate process (fig. 410, p. 263). A special catheter, introduced by the nose, can be passed within the opening, and air can be forced through the tube into the tympanum. The posterior lip of the tube is prominent and vertical, and contains the inner basal part of the Eustachian cartilage. Posterior to the opening will be seen the lateral recess of the pharynx, passing outwards behind the inner third of the tube, which therefore may be compressed by a hypertrophy of the adenoid tissue contained in the wall of the recess (fig. 410). The anterior lip of the Eustachian opening is flat, and is bound to the posterior border of the internal pterygoid plate.

The TYMPANIC OPENING of the tube will be seen in the anterior wall of the tympanum (see anterior half of section and fig. 415). It opens above the level of the tympanic floor.

WALLS OF THE EUSTACHIAN TUBE.—The tube passes inwards and forwards, and slightly downwards, from the tympanum to the pharynx; its length is 35 to 40 mm. ($1\frac{3}{4}$ inch); its outer third lies in a narrow bony canal; in its inner two-thirds, where the tube shows a vertical cleft on section, it is bounded behind by a triangular plate of cartilage; its anterior or outer wall is thin and fibrous. The student must refer to the base of a skull to understand the relationship of the Eustachian tube to the cranial bones. He will find a groove between the petrous bone and the posterior border of the great wing of the sphenoid; externally the groove terminates in a canal at the spine of the sphenoid. To the groove is attached the upper border of the triangular *Eustachian cartilage* which forms the posterior or inner wall of the tube (fig. 397, p. 243); the base of the cartilage projects within the pharynx; its apex ends at the opening of the bony Eustachian canal. The bony canal is seen to be subdivided by a horizontal shelf of bone, the *cochleariform process*, into an upper and lower compartment (fig. 416). The upper compartment contains, as will be seen presently, the *tensor tympani* muscle; the lower compartment serves as the air passage. The tympanic plate forms the floor of the bony part of the Eustachian canal.

FIG. 416.—SECTION OF THE EAR PASSING FROM BEHIND FORWARDS AND INWARDS, AND EXPOSING THE ANTRUM OF THE MASTOID AND EUSTACHIAN TUBE. (*Politzer.*)



1. Eustachian tube. 2. Tensor tympani muscle. 3. Promontory, with tympanic plexus of nerves. 4. Stapes, in fenestra ovalis. 5. Facial nerve in aqueduct of Fallopius. 6. Mastoid antrum. 7. Large diploetic mastoid cells. 8. Pyramid, with stapedius muscle escaping from its apex.

The student should now dissect out the EUSTACHIAN CARTILAGE and verify its attachments. Along the floor of the tube and slightly in front of it lies the levator palati muscle (fig. 392, p. 236). Along its anterior or outer fibrous wall, from the base of the internal pterygoid plate to the sphenoidal spine, rises the tensor palati (fig. 397, p. 243). The Eustachian tube passes to the pharynx above the upper border of the superior constrictor (fig. 392). The internal carotid artery will be seen to run obliquely inwards and forwards on its roof; the Vidian nerve also crosses above it (fig. 413). Its vascular supply is derived from the ascending palatine, pharyngeal, and the pterygo-palatine vessels (fig. 409); its nerves from the pharyngeal branch of Meckel's ganglion and the tympanic branch of the glosso-pharyngeal.

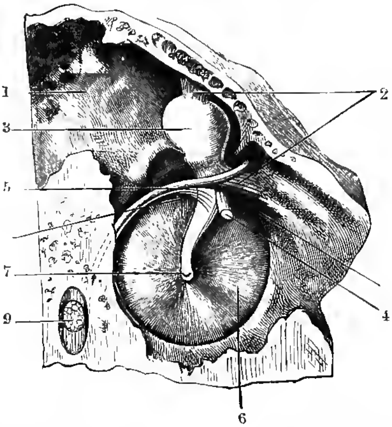
Cavity of the Tympanum (figs. 414, 415).—The student should now turn to the tympanum and examine it on both aspects of the divided temporal bone. The first point to strike him is its extreme narrowness; from its *outer wall* formed by the membrana tympani to its *inner bony wall* is a distance of only 4 mm. ($\frac{1}{6}$ inch); its height gives it the appearance of a vertical cleft; its *floor*, formed by the tympanic plate, and its thin *roof*, by the tegmen tympani, are 16 mm. ($\frac{2}{3}$ inch) apart. It will be observed that the cavity rises above the level of the membrana tympani, and this part of the cavity is distinguished as the *attic*. It contains the head of the *malleus* and the greater part of the *incus*. Opening into the attic of the tympanum *behind*, is the antrum of the mastoid, an air sinus situate in the mastoid part of the temporal bone, and frequently the seat of a chronic and dangerous inflammation. On the anterior wall of the tympanum opens the Eustachian tube.

Intra-petrous Stage of the Facial Nerve.—The Facial (VII) nerve has already been seen to enter the internal auditory meatus and to make its exit by the stylo-mastoid foramen (pp. 123, 134). Between its entrance and its exit is its intra-petrous stage, which lies within the aquæductus Fallopii, and has an intimate relationship to the tympanum. This stage should now be investigated (see fig. 413). Its zigzag course may be divided here into three stages: (1) an *outward*, (2) a *backward*, and (3) a *downward* stage. The dissection of the facial nerve should be commenced by following backwards the great superficial petrosal nerve, which has already been seen to escape on the anterior surface of the petrous bone by the *hiatus Fallopii* beneath the dura mater. This nerve should be looked for on the undivided temporal bone, and the thin roof of its canal removed until the facial nerve is exposed within the aquæductus Fallopii. At this point the facial nerve bends backwards, and in its bend is situated the GENICULATE GANGLION, from which the great and small superficial petrosal nerves issue. By the careful use of a chisel and bone forceps the thin roof of the tympanum (tegmen tympani) may be removed. The facial nerve will be seen to pass backwards (stage 2) in its canal along the inner wall of the tympanum, just under the roof (figs. 414, 415); then, bending downwards (stage 3) in the posterior wall, it escapes at the stylo-mastoid foramen (fig. 413). The wall of the aquæductus Fallopii is thin and may be eroded by tympanic disease. One relationship should not escape notice. As it passes down in the posterior tympanic wall the nerve lies just within the mouth of the antrum; in any scraping or cutting operation on the inner wall of the antrum or attic, the nerve is liable to injury.

Branches from the Intra-petrous part of the Facial Nerve.—(*a*) The Great Superficial Petrosal Nerve (fig. 413) arises from the geniculate ganglion, and makes its exit by the hiatus Fallopii. In its course to Meckel's ganglion it passes forwards (1) beneath the dura mater; (2) through the foramen lacerum medium, above the Eustachian tube and beneath the internal carotid artery; (3) through the Vidian canal. As it enters this canal the *great deep petrosal* from the carotid plexus joins it; after this union the nerve is named the Vidian (fig. 413).

(*b*) The Small Superficial Petrosal Nerve lies parallel but internal to the Great. It leaves the skull at the petro-sphenoid suture and joins the otic ganglion. Only a part of its fibres comes from the geniculate ganglion; the others are derived from the tympanic plexus.

Fig. 417.—Outer wall of the tympanum. (*From Heath's 'Anatomy.'*)



1. Antrum. 2. Ligaments of malleus. 3. Head of malleus. 4. Tendon of tensor tympani. 5. Chorda tympani. 6. Membrana tympani. 7. Handle of malleus. 9. Facial nerve in aquæductus Fallopii.

(*c*) A minute *branch to the stapedius muscle* is supplied from the third (downward) stage of the nerve.

(*d*) The Chorda Tympani should be looked for by completely removing the tympanic roof of the undivided temporal bone. It arises from the facial above the stylo-mastoid foramen, and at once passes upwards and forwards through the tympanum to join the lingual nerve (fig. 417). It is distributed thus to the tongue (taste fibres) and submaxillary gland (secretory, &c.). It has already been seen as it grooves the inner aspect of the spine of the sphenoid before joining the lingual (fig. 358, p. 181). As it crosses the tympanum and handle of the malleus, the chorda is bound to the upper segment of the membrana tympani by a reflection of the mucous membrane lining the cavity. The nerve might be easily divided from the meatus as it crosses the tympanic membrane. The chorda enters the tympanum by piercing the posterior wall (*iter chordæ posterius*), and leaves the cavity at the outer side of the Eustachian opening by the *iter chordæ anterius*.

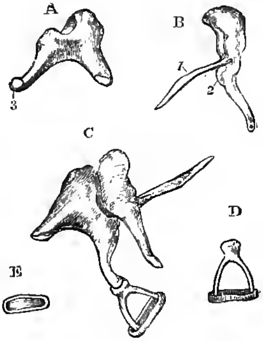
Intra-petrous Stage of the Internal Carotid Artery (see figs. 413, 415).—On the undivided temporal bone the apex of the petrous portion is to be removed by a bone forceps until the carotid canal is freely exposed. In passing through the petrous bone the internal carotid takes two distinct turns: (1) upwards until it reaches the anterior and inner angle of the tympanum (fig. 415); (2) then inwards and slightly forwards until it lies within the cavernous sinus (fig. 413). The partition between the carotid canal and tympanum may be occasionally very thin or even absent. In its second intra-petrous stage, the artery passes obliquely inwards above the Eustachian tube. A plexus of minute veins, communicating with the cavernous sinus, surrounds the internal carotid.

Carotid Plexus and Great Deep Petrosal Nerve.—The carotid plexus is a direct continuation of the sympathetic cord from the superior cervical ganglion. The plexus lies on the outer surface of the carotid artery. The small deep petrosal nerve from the tympanic plexus joins the carotid plexus (fig. 413); the great deep petrosal nerve leaves it to unite with the great superficial petrosal nerve in the Vidian canal and form the Vidian nerve. Through the deep petrosal nerve, Meckel's ganglion is connected with the tympanic plexus.

The TENSOR TYMPANI should now be exposed (fig. 416). Its thread-like tendon will be seen crossing the tympanum from over the tympanic opening of the Eustachian tube to the upper part of the handle of the malleus (fig. 415). By removing that part of the tegmen tympani which roofs over the Eustachian tube, the muscle may be exposed. It rises from the Eustachian cartilage and lies in the upper compartment of the bony Eustachian canal. Its nerve comes from the otic ganglion. The muscle regulates the tension of the membrana tympani through its attachment to the handle of the malleus.

Ossicles of the Middle Ear.—The Malleus consists of a rounded *head* lodged in the attic of the tympanum (see fig. 418 B, 419 *m*); a *neck*; a *handle* imbedded in the membrana tympani; and *two processes*, a short external jutting from the neck into the upper border of the membrane; an anterior, long and slender, from the upper part of the handle. The handle ends near the centre (the umbo) of the membrane. A ligament suspends the head of the malleus from the roof of the attic; another binds the short process to the outer wall of the attic above the superior attachments of the drum (fig. 419). A thin fibrous band joins the anterior process to the anterior inferior wall of the tympanum. In the fœtus it is continuous with Meckel's cartilage through the Glaserian fissure.

Fig. 418.—The ossicula auditus. (*Wilson.*)



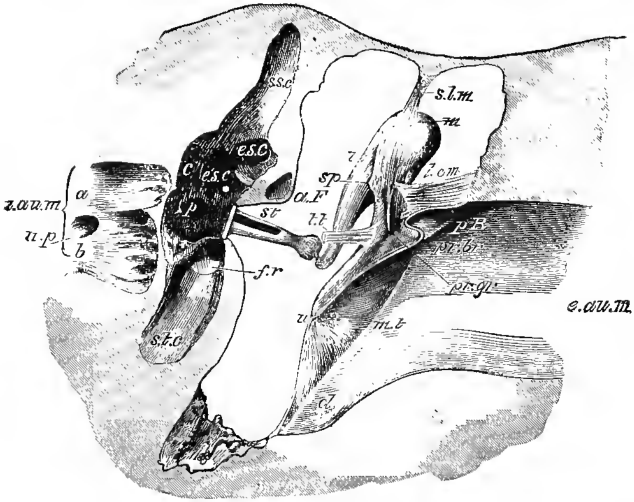
A. Incus. 3. Processus longus. B. Malleus. 1. Processus gracilis. 2. Processus brevis. C. Incus, malleus, and stapes articulated. D. Stapes. E. Base of stapes.

The vibration set up in the membrana tympani by sound waves also necessarily affects the handle of the malleus. As the handle moves inwards, the head rotates outwards and carries with it the body of the incus.

The Incus (fig. 418 A, 419 *i*) consists of a *body*, which embraces the head of the malleus, a short *horizontal process* projecting backwards to the mouth of the antrum, and a *vertical process* projecting downwards, internal to and almost parallel with the handle of the malleus. The body and short process are situated in the attic; a ligament suspends the body from the roof of the attic (fig. 419); another binds the short process to the opening of the mastoidal antrum. The articulation between the incus and malleus is such that an inward movement of the handle of the malleus is accompanied by a corresponding movement of the vertical process of the incus; on the other hand, the outward rotation of the handle of the malleus need not be accompanied by the vertical process of the incus. A capsular ligament, lined by a synovial membrane, unites the incus and malleus.

The Stapes (fig. 418 D, E, 419 *st.*) is attached to the lower end of the vertical process of the incus, and hence moves with it. The oval foot-plate of the stapes fits within the foramen ovale on the inner tympanic wall, and its circumference is bound to the edge of the foramen by membranous tissue—the annular membrane. The handle of the malleus and vertical process of the incus convey the vibrations of the drum to the foot-plate of the stapes, which moves within the foramen ovale. The foot-plate of the stapes transmits the vibrations to the fluid (perilymph) in the vestibule—the cavity lying internal to the tympanum (fig. 424, p. 288). In the vestibule, surrounded by the perilymph, are the saccule and utricle containing sensory end-organs of the internal ear.

Fig. 419.—Profile view of left tympanic cavity, membrane and ossicles. (*E. A. Schäfer.*)



m. Head of the malleus. *sp.* Spur-like projection of lower border of articular surface. *pr.br.* Processus brevis. *pr.gr.* Processus gracilis. *s.l.m.* Suspensory ligament of malleus. *l.e.m.* External ligament. *t.t.* Tensor tympani (cut). *i.* Incus (long process). *st.* Stapes in fenestra ovalis. *e.au.m.* External meatus. *p.R.* Rivinian recess. *m.t.* Membrana tympani. *u.* Umbo. *d.* Declivity at inner end of external meatus. *i.au.m.* Internal meatus. *a* and *b.* Its upper and lower divisions. *n.p.* Canal for nerve to ampulla of posterior semicircular canal. *s.s.c.* Ampulla of superior semicircular canal. *p.* Ampullary opening of posterior canal. *c.* Common aperture of superior and posterior canals. *e.s.c.* Ampullary—and *e′.s.c.* non-ampullary end of external canal. *s.t.c.* Scala tympani of cochlea. *f.r.* Fenestra rotunda. *a.F.* Aquæductus Fallopii.

The stapes should be examined in both the divided and undivided temporal bones. The posterior limb of the stirrup is the longer; they unite externally in a neck and head. The os orbiculare, a slight bony nodule, lies between the stapes and incus, and becomes ossified, during fœtal life, to the vertical process of the incus.

STAPEDIUS MUSCLE AND PYRAMID (fig. 416, 8).—The pyramid, a slight bony process on the posterior wall of the tympanum, projects behind the stapes (420, 8). It is hollow; from its apex emerges the tendon of the tiny stapedius muscle. By the insertion of its tendon to the neck of the stapes, the stapedius muscle can retract the outer end and regulate the mobility of that bone. The muscle can be exposed when the vertical part of the aquæductus Fallopii is exposed from behind. The stapedius is supplied from the facial nerve.

The **Membrana Tympani,** or drum of the ear, separates the external meatus from the tympanum. Sound waves set up vibrations in it, which are conveyed through the ossicles to the perilymph and endolymph within the inner ear.

The membrane should be studied both in section and from its inner side. It is displayed in the vertical sections (figs. 414, 415), and in order to study its inner aspect the tympanum should be divided from above downwards, so that the mastoid and squamosal part of the temporal, with the membrana *in situ*, are separated from the petrous part of the bone (see fig. 417).

APPEARANCE DURING LIFE.—When the healthy membrana tympani is viewed through the external meatus during life, the following points can be noted (fig. 420):

(1) The silhouette of the handle of the malleus, passing downwards and backwards.

(2) Behind it the shadow of the descending process of the incus.

(3) A cone of light with its apex at the tip of the handle (at the umbo) and its base downwards and forwards.

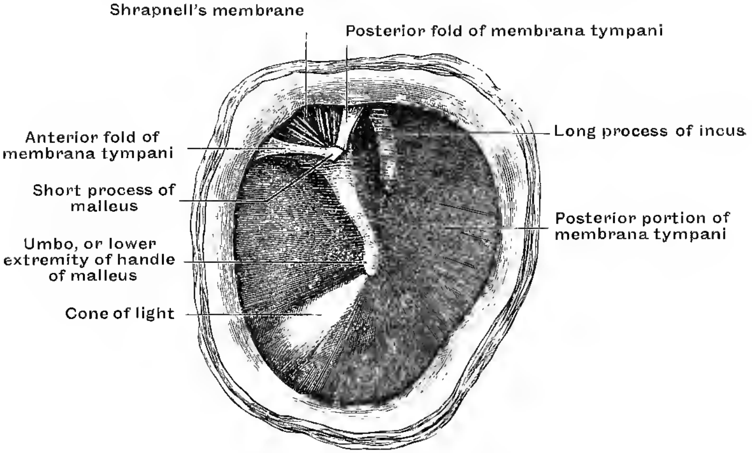
(4) The pars flaccida (Shrapnell's membrane) at the upper margin and the projection of the short process of the handle.

(5) The glistening pearly surface of the membrane.

STRUCTURE.—The membrane is set obliquely; its outer surface looks outwards, downwards, and forwards; its obliquity is even greater at birth and in the young, in whom the membrane and the meatal floor meet at a very acute angle. The membrane is concave externally, the umbo forming the deepest point of the concavity. Its circumference is set in a groove, which, however, is incomplete above, and here occurs the thin flaccid part of the drum. On microscopic section the drum is seen to be made up of a thin basis of fine fibres covered externally by stratified epithelium continuous with the skin lining the meatus; the ciliated columnar epithelial lining of the tympanum forms its inner covering. The handle of the malleus and the chorda tympani are covered by and bound to the drum by the mucous membrane (fig. 417).

The drum receives its *blood supply* from the tympanic and meatal branches of the internal maxillary and posterior auricular. Its nerves are derived from the auricular branch of the vagus, the auricular branches of the auriculo-temporal and tympanic branches of the glosso-pharyngeal (see fig. 311, p. 107).

FIG. 420.—EXTERNAL VIEW OF THE LEFT MEMBRANA TYMPANI, ENLARGED. (*From Morris's 'Anatomy.'*)

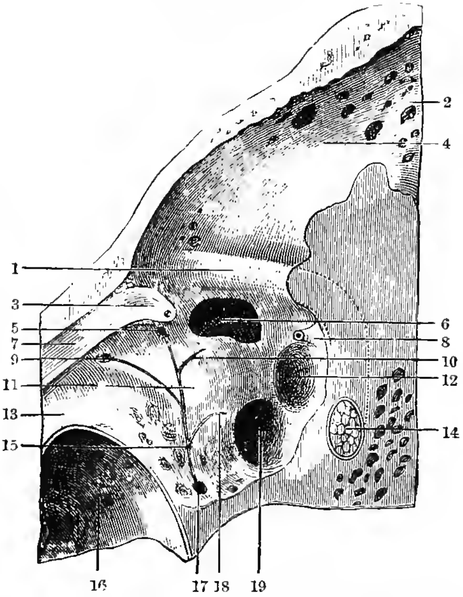

Shrapnell's membrane
Posterior fold of membrana tympani
Anterior fold of membrana tympani
Long process of incus
Short process of malleus
Posterior portion of membrana tympani
Umbo, or lower extremity of handle of malleus
Cone of light

The **Antrum and Air Cells of the Mastoid.**—In the vertical transverse section (fig. 414, p. 271) the antrum was seen to open in the posterior wall of the attic of the tympanum. The vertical antero-posterior section just made shows its extent and relationships (figs. 416, 417, 421). It is lined with a mucous membrane continuous with that of the tympanum. It varies in size, but, as a rule, is big enough to contain a small bean. The thin, almost paper-like tegmen tympani forms its roof and separates it from the third temporo-sphenoidal convolution; a thin plate of bone, seldom more, and often less than a quarter of an inch, separates it posteriorly from the lateral sinus. In its inner wall, near the opening in the attic, are the facial nerve and external semicircular canal (fig. 414). Some of the deeper mastoidal cells open into it, especially on its outer wall.

Age Changes.—At **birth** the mastoidal antrum is quite superficial, being situated above and behind the external auditory meatus and covered by a thin plate of bone. The mastoid process is developed after birth, the cells gradually forming as the process grows. In the adult the antrum is buried beneath the mastoidal cells and lies at a depth of ½ to ¾ inch from the surface. The post-meatal spine and triangle indicate its position superficially (fig. 311, p. 107). The student should observe that the lateral sinus descends on the deep aspect of the mastoid process about ¾ inch behind the external auditory meatus.

The **Inner Wall of the Tympanum** forms the outer wall of the vestibule (fig. 414), the cavity in which the organ of the internal ear is situated. On it are to be seen (fig. 421):

Fig. 421.—The inner wall of the tympanum. (*After Poirier.*)



1. Ridge corresponding to aquæductus Fallopii. 2. Mastoid cells. 3. Anterior pyramid. 4. Mastoid autrum. 5. Groove for small superficial petrosal nerve. 6. Fenestra ovalis. 7. Canal for tensor tympani. 8. Posterior pyramid. 9. Groove for twig to Eustachian tube. 10. Ditto to fenestra ovalis. 11. Promontory. 12. Sub-pyramidal fossette. 13. Eustachian tube. 14. Facial nerve in aquæductus Fallopii. 15. Groove for Jacobson's nerve. 16. Jugular fossa. 17. Aperture of entry of Jacobson's nerve in floor. 18. Groove for twig to fenestra rotunda. 19. Fenestra rotunda.

(*a*) The *foramen ovale* or fenestra ovalis (6), a window between the vestibular and tympanic cavities. It contains the foot-plate of the stapes and its binding membrane—the annular membrane.

(*b*) The *foramen rotundum* or fenestra rotunda (19), partly hid behind and below the promontory, is also a window in the vestibular wall. It is closed by a membrane (membrana secundaria), which forms the fundus of the scala tympani.

(*c*) The *promontory* (11), an eminence due to the first spiral turn of the cochlea.

(*d*) The *tympanic plexus of nerves* (15), which supplies the mucous membrane of the cavity, the antrum and Eustachian tube. The plexus is imbedded in the membrane covering the inner wall. By scratching the membrane over the promontory with the point of a knife, the tympanic (Jacobson's) branch of the glosso-pharyngeal will be found ascending and entering into the formation of the plexus (fig. 413, p. 268). The nerve springs from the jugular ganglion of the glosso-pharyngeal and immediately enters the floor of the tympanum by a minute opening in the crest between the carotid canal and jugular foramen. The plexus communicates in front with the carotid plexus of the sympathetic (small deep petrosal) (fig. 413), and with the petrosal branches of the facial. Some of the fibres of the small deep petrosal pass through the carotid plexus to join the great deep petrosal, and thus reach the spheno-palatine ganglion. Some fibres join the small superficial petrosal nerve and thus reach the otic ganglion.

(*e*) The *tympanic branch* of the ascending pharyngeal artery accompanies the nerve of Jacobson on the inner wall, and ends in its mucous membrane. The corresponding vein lies with the artery.

(*f*) The facial nerve in the aqueduct of Fallopius is seen to skirt the upper and posterior boundaries of this wall (fig. 421, 1).

BLOOD SUPPLY OF THE TYMPANUM.—Other small vessels besides the *tympanic artery* assist in the vascular supply of the tympanum. The *stylo-mastoid artery*, a branch of the posterior auricular, communicates in the aquæductus Fallopii, along the facial nerve, with a branch of the *internal auditory*, and from them small vessels pass within the tympanum. The *petrosal branch* of the middle meningeal perforates at the hiatus Fallopii to join the communication along the facial nerve. Veins pass through the roof to join the *petro-squamosal sinus* (fig. 414), situated in the petro-squamosal suture, and through it the tympanic venous blood reaches the lateral sinus and meningeal veins.

The **Internal Auditory Meatus** (see figs. 414, 415) is about

8 mm. deep, its fundus being formed by a cribriform plate (*lamina cribrosa*), which separates the meatus from the cavities of the vestibule and cochlea. It contains the following structures:

(*a*) The Auditory (VIII.) Nerve and cells of the vestibular ganglion.

(*b*) The Facial (VII.) Nerve.

(*c*) The Pars Intermedia, which joins the Facial.

(*d*) The internal auditory artery, a branch of the basilar.

(*e*) A sheath of arachnoid.

(*f*) A sheath of dura mater which is firmly adherent to the meatal wall.

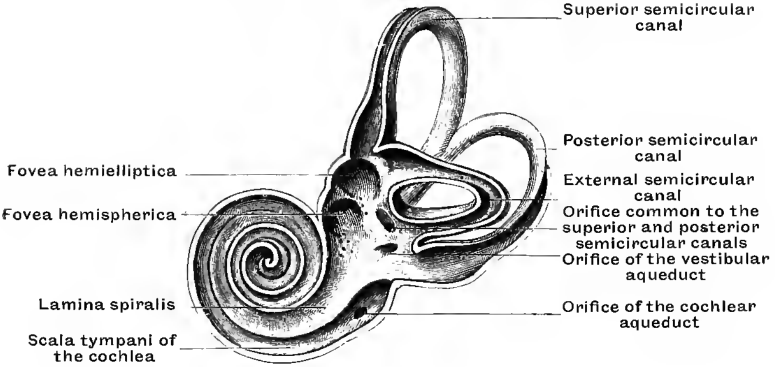
When its contents are dissected out and removed, the cribriform plate is seen to be divided into an upper and lower area by the falciform crest (fig. 415). In the upper area open the aquæductus Fallopii for the Seventh; two foramina, one for the nerve to the utricle, and the other for the superior and external semicircular canals. In the lower division are seen numerous foramina for the cochlear fibres arranged in a spiral, a foramen for the nerve to the saccule, and another for the nerve to the posterior semicircular canal.

Internal Ear.—Before proceeding with the dissection of this part the student must first consult sections made in the dried bone, and then identify in his dissection the parts seen in the dried specimen. He must further aid himself by the use of the more elaborate diagrams of the membranous labyrinth given in systematic treatises of Anatomy or Physiology.

I. The VESTIBULE (fig. 414) is a cavity situated between the tympanum and internal auditory meatus. The cribriform plate assists to form its inner wall, and admits the nerves for the saccule and utricle which are contained in the vestibule (fig. 423). Its outer wall, which is also the inner wall of the tympanum, is perforated by the fenestra ovalis and fenestra rotunda. The vestibule, in reality a great lymph space in the petrous bone, contains perilymph during life, besides the saccule and utricle. Through the concussion caused by the movable stapedial shutter, set in its outer wall, the vibrations of the drum are conveyed to the perilymph, and by the perilymph to the saccule and utricle which are surrounded by it (fig. 424).

II. The BONY SEMICIRCULAR CANALS open into the vestibule behind (fig. 422). There are three of them: the *superior* and *posterior* give rise to elevations on the upper and posterior surface of the petrous bone; the *external* lies deeply, its convexity reaching the inner wall of the mastoidal antrum (fig. 414). The three canals are so arranged as to form in miniature a three-sided chair; the external is horizontal, and forms the seat; were a midget to take possession of it, its face would be directed equally outwards and backwards, its right arm would rest on the superior canal, its left on the posterior, while the conjoined limbs of the posterior and superior form a resting-place for its back. It will be noticed further that the superior canals of the two sides lie in a vertical coronal plane, the posterior in an antero-posterior sagittal plane; the horizontal lie in the equatorial plane of the head.

Fig. 422.—Interior of the osseous labyrinth of the left side. (*Hensman, after Soemmerring. Enlarged.*)


Superior semicircular canal
Posterior semicircular canal
Fovea hemielliptica
External semicircular canal
Fovea hemispherica
Orifice common to the superior and posterior semicircular canals
Orifice of the vestibular aqueduct
Lamina spiralis
Orifice of the cochlear aqueduct
Scala tympani of the cochlea

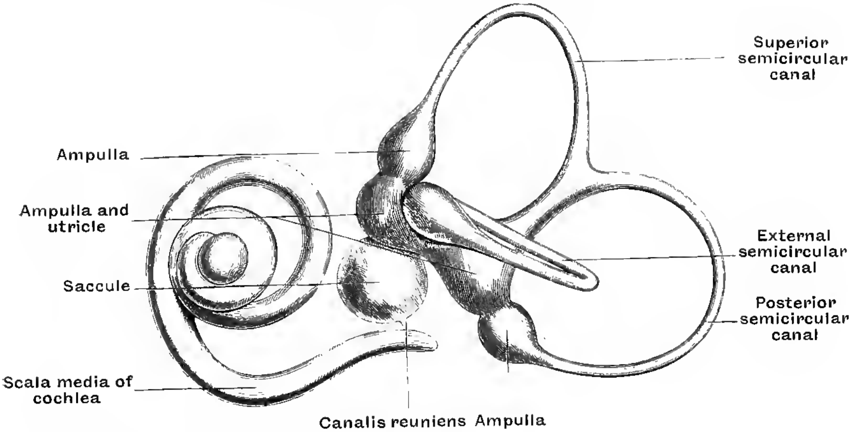
In the recent state a canal shows in section (*a*) a dense wall of bone; (*b*) a thin lining membrane; (*c*) a perilymph compartment continuous with the vestibular perilymph, and therefore influenced by the movements of the stapes; (*d*) a membranous canal which contains endolymph, and opens into the utricle (fig. 423).

As already mentioned, the adjacent limbs of the superior and posterior semicircular canals join, and have a common opening to the vestibule. At the vestibular extremity of one limb of each canal there is a dilatation—the ampulla (fig. 422). It contains a corresponding dilatation of the membranous canal, in which are situated the sensory hair cells (fig. 423).

III. The COCHLEA in the dried specimen is a funnel-shaped tube of dense bone which has been coiled on itself for two turns and a half (fig. 422). The wide end of the first turn is continuous with the vestibule. On its inner wall a slight bony shelf projects—the *lamina spiralis.* The cochlear foramina, seen on the cribriform plate, open on the lamina and allow the cochlear nerves to enter from the internal meatus. The fenestra rotunda, closed by its membrane, is situate at the basal or vestibular end of the cochlea, and in dried specimens looks as if it really were an opening in the outer vestibular wall (fig. 414).

AQUÆDUCTUS COCHLEÆ.—The student is probably familiar already with the triangular opening of the aqueduct on the anterior border of the jugular fossa, below and internal to the internal auditory meatus. Within it lies a vein which, beginning in the vestibular end of the cochlea (fig. 422), ends in the jugular. Into it and along its sheath the perilymph escapes.

FIG. 423.—ENLARGED DIAGRAMMATIC VIEW OF MEMBRANOUS LABYRINTH. (*From Morris's 'Anatomy.'*)

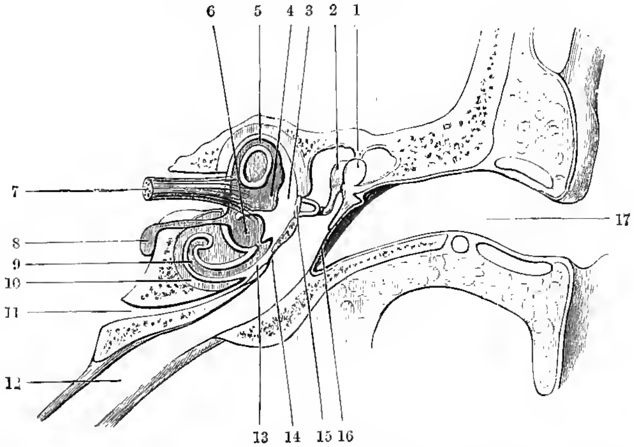

Superior semicircular canal
Ampulla
Ampulla and utricle
External semicircular canal
Saccule
Posterior semicircular canal
Scala media of cochlea
Canalis reuniens
Ampulla

The MEMBRANOUS LABYRINTH cannot be satisfactorily examined; all the student may do is to partially verify the full descriptions given in systematic treatises. Fig. 423 may assist him.

Within the vestibule, surrounded by perilymph, are the minute *saccule* and *utricle.* They are connected by a Y-shaped narrow tube—the *ductus endolymphaticus,* the stalk of which ends blindly in the *hiatus vestibuli* on the posterior aspect of the petrous bone (fig. 424). Through it the endolymph may escape and join the subdural lymphatics. Both the saccule and utricle contain sensory cells, connected with fibres from the VIIIth nerve, which perforate the lamina cribrosa (fig. 424).

The THREE MEMBRANOUS SEMICIRCULAR CANALS open from behind and above into the utricle, the endolymph of the canals being in continuity with that of the utricle; one limb of each canal is dilated into an ampulla near its termination in the utricle, and contains sensory epithelium in which branches of the VIIIth nerve terminate.

FIG. 424.—SCHEME OF AUDITORY APPARATUS. (*After Poirier.*)



1. Malleus. 2. Incus (line passes through attic). 3. Perilymph in vestibule. 4. Utricle. 5. Superior semicircular canal. 6. Saccule. 7. Auditory nerve. 8. Saccus endolymphaticus. 9. Membrana cochleæ (canalis cochleæ). 10. Cochlea. 11. Aquæductus cochleæ. 12. Eustachian tube. 13. Scala tympani. 14. Fenestra rotunda. 15. Stapes. 16. Membrana tympani. 17. External auditory meatus.

THE SCALA MEDIA OF THE COCHLEA.—A transverse section of the cochlear canal shows that, in the recent state, it is divided into three compartments by two membranous septa. These septa are attached together to the spiral lamina on the inner wall of the cochlear canal, but at their attachment to the outer or tympanic wall are separated so as to enclose between them the *scala media.* The scala media ends blindly at the apex of the cochlea and contains endolymph. The cochlear branches of the VIIIth nerve end in sensory epithelium in the floor of the scala media. A narrow canal, the *canalis reuniens,* joins it to the saccule (fig. 423). Thus it will be seen that the membranous labyrinth, consisting of scala media, canalis reuniens, saccule, utricle, ductus endolymphaticus and semicircular canals, is merely a subdivided and complicated sac which contains the endolymph and auditory cells (fig. 423).

Scala Vestibuli and Scala Tympani.—The two other compartments of the cochlea contain perilymph and communicate at the apex of the cochlea (fig. 422). The upper compartment, the *scala vestibuli*, commences by an opening into the anterior part of the vestibule, winds to the apex of the cochlea to become continuous with the lower compartment, the *scala tympani*, which terminates blindly at the membrane closing the fenestra rotunda on the inner wall of the tympanum.

The **essential points** which must be understood and verified as far as possible by the student are (see fig. 424) :

(1) The conduction of the drum vibrations to the perilymph by the ossicles in the tympanum.

(2) The transference of these vibrations from the perilymph to the endolymph within the membranous labyrinth.

(3) The transference of the nerve impulses set up by these stimuli in the auditory epithelium to the brain by the auditory or VIIIth nerve.

DISSECTION XXII

THE SPINAL CORD[1]

Dissection to Expose the Cord.—Before commencing the actual dissection to expose the cord, the student should make himself acquainted with the general arrangement of the structures which surround it and require to be cut in exposing the cord. Without a general conception he will have difficulty in recognising the structures as they are encountered. For this purpose he ought to consult such a section of the spinal cord

---

[1] Although the structures encountered in the extraction of the spinal cord are described here under the anatomy of the spinal cord, it is intended that they should be examined after the dissection of the muscles of the back and removal of the brain. When the student comes afterwards to examine the central nervous system, he is expected to re-read this dissection (see page 113).

in situ as is shown diagrammatically in fig. 425, and note the following outstanding points :

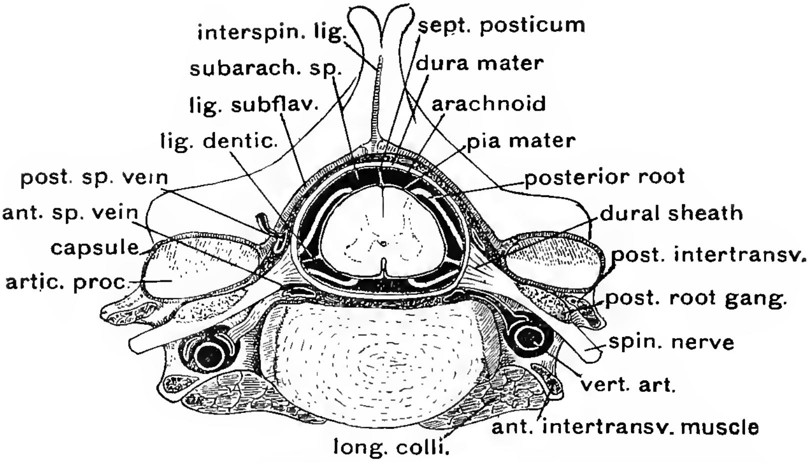
(1) The spinal cord and its sheath or capsule, the *pia mater.* On the pia mater the arteries of the cord ramify and give off perforating branches.

(2) The *Subarachnoid Space.*—It contains cerebro-spinal fluid, and is continuous with the subarachnoid spaces round the brain and medulla (fig. 432, p. 303).

(3) The thin translucent *arachnoid* bounding the subarachnoid space.

(4) The *dura mater* surrounding, and in contact with, the arachnoid. The arachnoid is easily separable from the dura mater; the space between them is the subdural—a potential space.

FIG. 425.—SECTION ACROSS THE CERVICAL PART OF THE SPINAL CORD AND ITS MEMBRANES. (*Semi-diagrammatic.*)



(5) The *anterior and posterior nerve roots* passing from each side of the spinal cord through the subarachnoid space, perforating separately the arachnoid and dura mater, and carrying on them prolongations of these membranes as sheaths.

(6) The *posterior root ganglia* in the intervertebral foramina and outside the dura mater. Beyond the ganglia the roots unite to form a spinal nerve, which divides into anterior and posterior divisions (fig. 266, p. 2).

(7) The *ligamentum denticulatum* and *septum posticum,*

crossing the subarachnoid space from the pia mater to the arachnoid and dura.

(8) The *spinal canal*, formed by the bodies of the vertebræ in front; the laminæ and spines behind; the pedicles at the side. The pedicles stretch from the bodies to the articular processes. To expose the walls of the spinal canal and the intervertebral foramina with the root ganglia in them, the spines, laminæ, and articular processes require to be removed.

(9) Between the dura mater and the spinal canal is a layer of loose connective tissue containing the *intra-spinal plexus* of veins (fig. 429). These are connected by communicating veins with the *dorsal spinal plexus* on the outer aspect of the laminæ and spines (fig. 425).

(10) The muscles to be removed in the cervical region to expose the dorsal aspect of the spinal canal have been already examined (see fig. 266, p. 2). They are numerous. In the lumbar region, although the spinal canal lies at a greater depth from the surface, the actual layers to be removed are only three in number, viz.:—(*a*) the posterior layer of the lumbar fascia and origin of the latissimus dorsi; (*b*) the erector spinæ; (*c*) the multifidus spinæ (fig. 274, p. 25).

Roof of the Spinal Canal.—The roof of the spinal canal is formed by (1) the vertebral laminæ; (2) the interlaminar ligaments (ligamenta subflava). From the union of the laminæ spring the spinous processes. These are bound together by the supraspinous and interspinous ligaments (fig. 425). The roof is removed by the following steps:

(1) With a bone forceps the spines are nipped off from the laminæ. The fibrous supraspinous ligaments joining their tips are examined; the interspinous are membranous and contain some elastic fibres. In the neck the supra- and interspinous ligaments form the ligamentum nuchæ.

(2) The laminæ are then removed. Notice how those of the dorsal vertebræ overlap each other; there is only an *interlaminar space* in that region when the body is bent. In the lumbar and lower dorsal region the interlaminar spaces are wide, and it is easily possible to pass a needle through them and aspirate the cerebro-spinal fluid in the subarachnoid space. In the lumbar region the interspinous and interlaminar spaces correspond. The interlaminar spaces are narrow in the neck when the head is erect. Observe the veins of the dorsal spinal

plexus on the periosteum of the spines and laminæ (fig. 429). The laminæ are removed by inserting a blade of the forceps beneath them at their junction with the transverse processes. The articular processes are thus left *in situ.*

(3) A number of the *intervertebral foramina* must be exposed, examples being chosen in the lumbar, dorsal, and cervical regions.

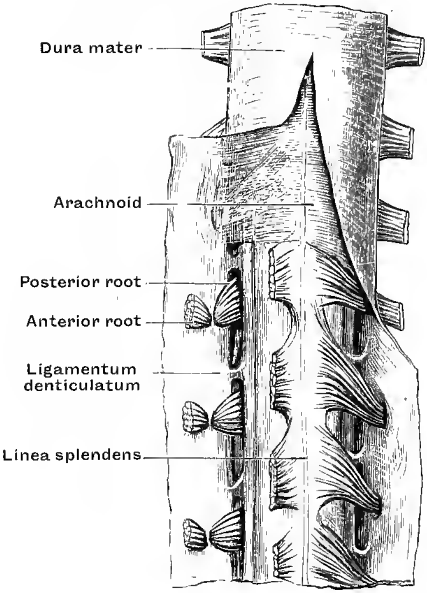
LIGAMENTA SUBFLAVA.—When the laminæ are raised, the ligamenta subflava are exposed on their under surfaces. They join the upper border of the lower lamina with the under surface of the one above, and stretch on each side from the capsular ligament of the articular processes to the root of the spine. They are extremely strong and composed of yellow elastic tissue. When the body is bent and the interlaminar spaces increased, they are put on the stretch. By their elasticity they assist in pulling the body erect again. There is a narrow space under the spine which separates the ligaments of the two sides (fig. 425). Through the space communicating veins pass between the intraspinal and extraspinal venous plexuses.

ARTICULAR PROCESSES.—The intervertebral foramina are exposed from behind by removing the articular processes and the capsular ligaments which surround them (see fig. 425). The capsular ligaments are only tense when the spine is flexed; they are relaxed when the spine is fully extended. The articular processes are most easily removed in the lumbar region. There the upper concave process receives the convex articular surface of the process above it. They are so shaped as to prevent rotation of one lumbar vertebra on another. In the cervical and dorsal regions the processes are flat and almost continuous with the laminæ (fig. 425). They are so set as to allow a rotatory movement.

The POSTERIOR ROOT GANGLIA are situated on the posterior roots in the intervertebral foramina (fig. 425). The two roots of each spinal nerve fuse at the outer extremity of each ganglion. A fibrous sheath, continuous with the dura mater, covers it; the lymph space which lies within the capsule is in communication with the subarachnoid cavity. Loose and fatty fibrous tissue fills the foramen. Spinal arteries and veins enter and emerge by the intervertebral foramina. The ganglia of the first cervical nerve (which may be absent) and of the second lie above and below the posterior arch of the atlas (fig. 384, p. 225). The sacral ganglia lie in the sacral canal.

Dura Mater (fig. 425).—The dura mater, the most external of the three spinal membranes, is now exposed. Much loose tissue, containing fat, and the thin-walled dilated veins of the intra-spinal plexus cover its outer surface. Each pair of nerve roots pierce it and pass to the intervertebral foramina (fig. 425). It forms a tubular, tough, fibrous sheath for the spinal cord and its inner membranes (fig. 426). Traced down into the sacral region of the canal, it tapers rapidly to a fibrous point on the third or fourth sacral vertebra (fig. 427). There it is lost on the fibrous tissue on the posterior aspect of the sacrum. The last sacral and coccygeal nerves pierce it at its termination (fig.427). Traced upwards to the cervical region it becomes wider, and above the level of the atlas it is adherent to the ligaments which unite the atlas and occipital bone (fig. 386, p. 228). In the neck its posterior part, which receives a large accession of fibres from the posterior margin of the foramen magnum, is much thicker and stronger than the anterior part (fig. 386, p. 228). It becomes continuous within the cranial cavity with the inner or supporting layer of the dura mater on the basilar aspect of the skull. The periosteal layer of the cranial dura mater is continuous with the ligaments and periosteum on the anterior part of the spinal canal.

Fig. 426.—View of the membranes of the spinal cord. (*Ellis.*)



It will thus be seen that the dura mater is adherent above at the foramen magnum and hangs as a free tube within the spinal canal. Each pair of nerves, as they pass out, fix it to the tissue filling the intervertebral foramina.

Arachnoid.—When the dura mater is laid open by buttonholing and then running the point of a knife or scissors along it, the thin translucent arachnoid will be seen applied to, but easily separable from its deep surface (fig. 425). It is a fine film-like membranous tube fitting the dura mater as a test tube of a smaller size fits within another, and is so delicate that it cannot be handled with a forceps without tearing. It bounds the subarachnoid space which separates it widely from the cord and medulla oblongata; but within the cranium, above the level of the medulla, it becomes adherent to the surface of the cerebellum and cerebrum. Below, it ends blindly with the dura mater in the upper part of the sacral canal. Each pair of spinal nerves carry with them a prolongation of the arachnoid; these prolongations reach to the spinal ganglia.

CONTENTS OF THE SUBARACHNOID SPACE (see figs. 425, 426).

(1) Spinal cord covered by pia mater.
(2) The nerve roots.
(3) Cerebro-spinal or subarachnoid fluid.
(4) Septum posticum.
(5) Ligamentum denticulatum.
(6) Spinal arteries and veins. The contents are seen when the arachnoid is opened.

The subarachnoid space is bounded by the arachnoid membrane and contains cerebro-spinal fluid. Above, the space is continuous with the cisterna magna behind the medulla and the cisterna pontis below the pons (fig. 432, p. 303). The spinal cord terminates near the lower border of the first lumbar vertebra. Below that level, the subarachnoid space contains the drawn-out roots of the lumbar and sacral nerves and filum terminale which form the cauda equina (fig. 427). It is in this region that the cerebro-spinal fluid is tapped and drawn off, through an interlaminar lumbar space. Fluid, it will be seen, can thus be drawn indirectly from the great arachnoid cisterns at the base of the brain.

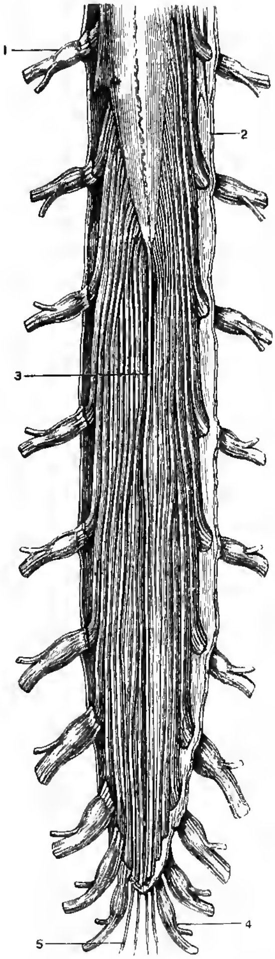
Pia Mater.—The pia mater forms a sheath for the spinal cord. It is bound closely to the cord, and cannot be easily detached. The fibres between the anterior columns, especially in the cervical region, form a smooth longitudinal stratum which strengthens the cord (linea splendens). The spinal arteries ramify in the pia mater before entering the cord; the radicles of the spinal veins unite in it. The membrane is inflected within the anterior fissure of the cord; a septum of the pia mater fills the posterior fissure.

FILUM TERMINALE.—At the termination of the cord (conus medullaris) the pia mater is continued onwards, as a fibrous thread, and ends with the termination of the dura mater in the tissue over the posterior aspect of the sacrum (fig. 427, 3). The central canal of the spinal cord passes downwards some way within the filum terminale.

LIGAMENTUM DENTICULATUM (figs. 425, 426).—From each side of the spinal cord processes of the pia mater project outwards like the teeth from a saw (fig. 428, 16, 16). The pointed ends are fixed to the arachnoid and dura mater; the basal end is attached between the anterior and posterior nerve roots (fig. 425). They form a continuous series commencing above at the level of the foramen magnum, and ending below at the first lumbar vertebra. They bind the cord to the dura mater.

The SEPTUM POSTICUM (fig. 425) is an incomplete partition of thin, translucent, very delicate membrane, stretching between the posterior fissure of the cord and the dorsal median line of the arachnoid.

FIG. 427.—THE CAUDA EQUINA, SEEN FROM BEHIND. (*From Hirschfeld and Leveillé.*)



1. Root of 12th dorsal nerve. 2. Dura mater laid open. 3. Filum terminale. 4. Fourth sacral nerve. 5. Fifth sacral and coccygeal nerves.

Spinal Vessels.—The following arteries supply spinal branches:

(1) *Cervical region.*—The vertebral, ascending cervical and deep cervical (see fig. 384, p. 225).

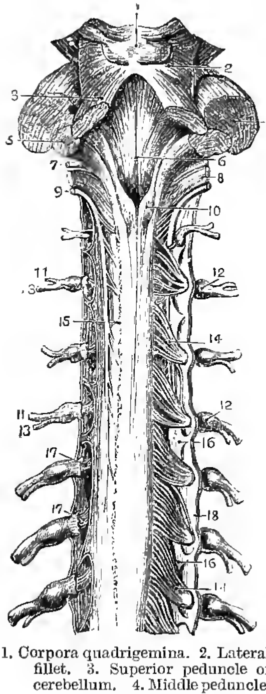
(2) *Dorsal region.*—The intercostal arteries.

(3) *Lumbar region.*—The lumbar arteries and lumbar branch of the ilio-lumbar.

(4) *Sacral region.*—Lateral and middle sacral.

The spinal arteries enter at the intervertebral foramina. Some of them give off branches along the nerve roots to the cord. The spinal artery terminates in the spinal canal by dividing into anterior and posterior branches. They supply the vertebræ, ligaments, joints, and dura mater.

Fig. 428.—Fourth ventricle and upper part of spinal cord and membranes. The posterior roots of the nerves are removed on the left side. (*Hirschfeld and Leveillé.*)



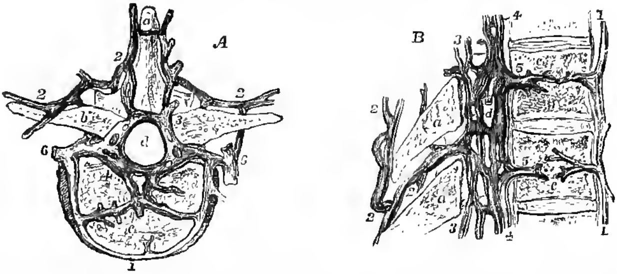
1. Corpora quadrigemina. 2. Lateral fillet. 3. Superior peduncle of cerebellum. 4. Middle peduncle. 5. Inferior peduncle. 6. Floor of fourth ventricle. 7. Glossopharyngeal nerve. 8. Pneumogastric nerve. 9. Spinal accessory nerve. 10. Posterior pyramids of medulla. 11, 11. Anterior divisions of spinal nerves. 12, 12. Ganglia of nerves. 13, 13. Posterior divisions of spinal nerves. 14, 14. Posterior roots of spinal nerves. 15. Line of origin of posterior roots of left side. 16, 16. Ligamentum denticulatum. 17, 17. Anterior root of spinal nerves. 18. Dura mater.

The **Spinal Veins** (fig. 429, A and B) form an *intraspinal plexus* between the dura mater and walls of the spinal canal. Two *anterior longitudinal* vessels unite the plexus on the bodies of the vertebræ; two *posterior longitudinal* vessels unite the veins of the posterior plexus under the laminæ (fig. 425). Large veins (venæ basis vertebrarum) (fig. 429, 5) emerge from the bodies of the vertebræ beneath the posterior common ligament, and join the anterior plexus and anterior longitudinal veins; they come from the blood-forming red marrow of the vertebral bodies. The posterior veins communicate with the dorsal spinal plexus between the laminæ (fig. 429). The *dorsal spinal* or *extraspinal plexus* communicates with subcutaneous veins along the spinous processes. Spinal veins emerge at the intervertebral foramina and drain the intraspinal plexus into the veins corresponding to the arteries which supply the spinal branches (see fig. 425). Veins from the anterior aspect of the bodies of the vertebræ join the spinal veins (fig. 429, 1).

Arteries of the Cord.—Many of the spinal arteries, from the vertebral at the upper end to the sacral at the lower, give off branches to the cord. These branches reach the cord on the roots of the spinal nerves. When the arteries reach the cord they form three anastomotic chains along it from its upper to its lower end. The anterior median chain (*anterior spinal artery*) lies in the anterior fissure. The two irregular posterior chains (*posterior spinal arteries*) are on the posterior aspect of the cord, one behind the posterior roots on each side.

As the vertebral arteries pass on each side of the lower end of the medulla oblongata (fig. 312, p. 112), each gives off a posterior spinal artery which forms the commencement of the posterior arterial chains; and an anterior, which unites with the corresponding branch of the opposite side, and forms the upper end of the anterior median chain. The chainwork is continued by branches from cervical, intercostal, lumbar, and sacral spinal arteries.

Fig. 429.—Vertebral and spinal veins.
A. horizontal view. B. vertical view. (*Breschet.*)



a. Spinous process. *b.* Transverse process. *c.* Body of vertebra. *d.* Spinal canal. 1. Anterior external veins of body. 2. Dorsal spinal veins. 3. Posterior longitudinal spinal veins (meningo-rachidian). 4. Anterior longitudinal spinal veins (meningo-rachidian). 5. Venæ basis vertebrarum. 6. Spinal veins.

From the anterior spinal chain, vessels pass to the depth of the anterior median fissure. There they divide, and branches pierce to the grey matter of the cord. An arterial network is formed by other branches in the pia mater. Branches from the network pierce and carry with them a pial sheath into the cord. The arterial branches which form the posterior chains enter on the posterior roots, and are distributed in the pia mater, some of them entering the posterior median fissure.

The Veins of the Spinal Cord have thin walls, and in the lumbar region are tortuous and sometimes dilated. They emerge from the cord and form a plexus which ends in venous chains corresponding to the arterial. The veins leave on the nerve roots and join the spinal veins in the intervertebral foramina.

Posterior Nerve Roots.—From the posterior root ganglion are developed both the root fibres, which grow into the cord, and the nerve fibres which pass into the body. These fibres form sensory or afferent pathways for nerve impulses from the body to the cord. The distribution of each pair of posterior roots to a circle or segment of skin has already been traced. So much do neighbouring nerves apparently overlap in their distribution, that the root of one nerve may be cut without loss of sensation. The fibres of a posterior root spread out as they reach the cord, so that, along the postero-lateral groove of the cord, the posterior root fibres form a continuous series ; the fibres of neighbouring roots may even overlap (fig. 428).

The posterior root fibres and their collateral fibres, which are given off as the root fibres enter the cord, form the postero-mesial (column of Goll) and postero-lateral (column of Burdach) columns of the cord (fig. 430, 17, 18). Sensory impulses coming in by the posterior roots pass up by these columns of the cord.

Anterior Nerve Roots.—The fibres of the anterior roots are produced from cells in the anterior horn (fig. 430, 1). The fibres emerge in groups, one nerve root being distinctly separated from the next. The line of emergence of the anterior roots separates the anterior column of the cord from the lateral, but there is no distinct groove such as occurs at the entrance of the posterior root fibres.

POSITION OF THE CORD.—Until the end of the third month of fœtal life the spinal cord quite fills the spinal canal, extending from the foramen magnum to the lower end of the sacrum. After that month the spinal column grows more rapidly than the cord ; by the thirteenth year the conical lower end of the cord (conus medullaris) lies behind the first lumbar vertebra. The dura mater and arachnoid, however, keep pace in growth with the spinal column. To allow the cord thus to retract within the dura mater and canal, the lower nerve roots are greatly drawn out, forming the *cauda equina* (fig. 427), while the terminal part of the cord and its covering of pia mater are reduced to a fine cord, the *filum terminale* (fig. 427, 3). This ends with the termination of the dura mater in the fibrous tissue in the sacral canal.

Position of the Cervical and Lumbar Enlargements and Nerve Roots.—Those parts of the spinal cord which are connected with the limb nerves show enlargements. The brachial plexus springs from the *cervical enlargement*, the lumbar and sacral plexuses from the *lumbar enlargement*. The lumbar enlargement, owing to the retraction of the cord within the spinal canal, lies behind the bodies of the eleventh, twelfth dorsal, and first lumbar vertebræ. The spines of these vertebræ mark the level of the corresponding bodies on the back.

It will be thus seen that the roots of the lumbar and sacral nerves have a long intra-spinal course. The first sacral nerve, for instance, emerges below the first sacral vertebra ; it therefore descends behind all the lumbar vertebræ and the first sacral before it reaches its point of emergence.

The degree of intra-spinal descent for the roots of the brachial plexus is markedly less. The cervical enlargement lies behind the lower five cervical vertebræ and first dorsal. The roots of the first dorsal nerve, for instance, arise behind the body of the last cervical vertebra ; it descends below the first dorsal to emerge. The tip of the spine of the sixth cervical vertebra marks its level of origin from the cord ; the tip of the seventh spine marks its point of emergence from the canal. The upper three cervical nerves pass transversely outwards.

From the examples given, the student can infer the intra-spinal extent to which the roots of any particular nerve descend. He should remember that if the cord is injured at the level of the sixth dorsal vertebra, for instance, the seventh and eighth dorsal nerves, arising above the point of injury, may still remain intact and functional. From the level of the area of skin anæsthesia, the clinician may tell the point at which the spinal column is injured.

The cord is now removed from the spinal canal by dividing the spinal nerves in the intervertebral foramina, and put away with the brain for examination afterwards.

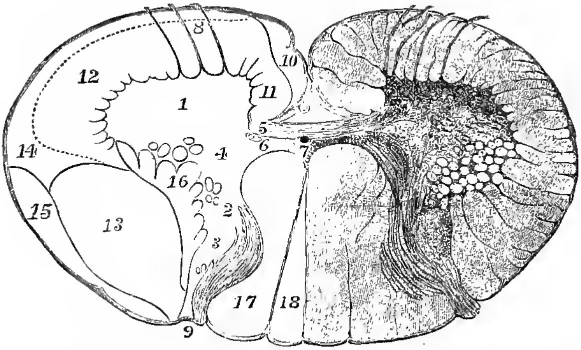
Transverse Sections of the Spinal Cord.—The relations and external appearances of the spinal cord having just been described, transverse sections should be made with the scalpel in the cervical, dorsal, lumbar and sacral regions of the cord (fig. 431). Portions of the cord should be cut by the microtome, stained, and examined under the microscope.

In a naked-eye section of the cord in the cervical region the following points should be noted (figs. 430, 431) :

(1) The *covering of pia mater.* It forms a capsule for the cord, specially thickened over the anterior columns : fibres pass from its deep surface into the substance of the cord. It sends a narrow septum within the posterior fissure and a fold within the anterior.

(2) The *anterior* (antero-median spinal artery) and two *posterior arterial chains* (postero-lateral spinal arteries). The spinal arteries form anastomoses in the pia mater ; vessels enter the substance of the cord, carrying sheaths with them.

Fig. 430.—Diagram of the tracts of the spinal cord. (*Gowers.*)



1. Anterior horn of grey matter. 2. Posterior horn. 3. Caput cornu posterioris. 4. Central grey matter. 5. Anterior (white) commissure. 6. Posterior (grey) commissure. 7. Central canal. 8. Anterior nerve root. 9. Posterior nerve root. 10. Direct pyramidal tract. 11. Anterior root zone (Anterior column). 12. Mixed zone. 13. Crossed pyramidal tract. 14. Ascending cerebellar tract. 15. Direct cerebellar tract. 16. Lateral reticular formation (Lateral column). 17. Tract of Burdach. Postero-lateral column. 18. Tract of Goll. Postero-mesial column.

(3) The separation of the cord into right and left halves by the shallow, wide *anterior fissure,* and the *posterior fissure,* deep, narrow, and containing a septum of pia mater.

(4) The *union* of the right and left halves by the posterior or grey commissure and the anterior or white commissure (fig. 430, 5, 6).

(5) The *central canal* (fig. 430, 7), merely a point to the naked eye, is situated in the grey commissure. Above, it opens into the fourth ventricle ; below, it ends in a dilatation within the upper part of the filum terminale. The spinal cord is

developed from a tube of cells; the central canal is the remains of the original tube. It is lined by columnar ciliated epithelium.

(6) The *entrance* of the *posterior roots* and the *exit* of the *anterior roots.* The posterior roots enter at the postero-lateral sulcus in a continuous and linear series (fig. 428). The anterior roots emerge in groups. The entrance of the posterior roots divides each half of the spinal cord into posterior and antero-lateral columns (fig. 431). The emergence of the anterior roots divides the antero-lateral column into anterior and lateral columns.

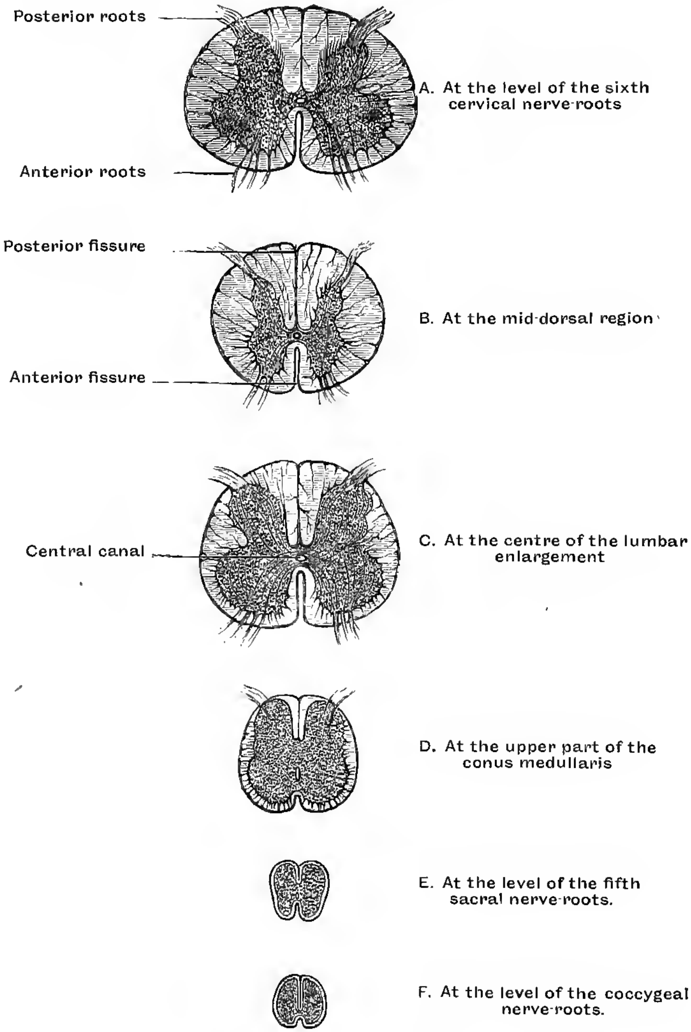
The **grey matter** of the cord forms on each side a continuous column of nerve cells and neuroglia, which, when seen in section, is comma-shaped. In the grey matter are situated the reflex centres of the trunk and limbs. The two grey columns are united by a continuous transverse band—the *grey commissure* (fig. 430).

When the grey matter of the cord is seen in section it has the appearance of two commas placed back to back and united by a hyphen. The hyphen is the grey commissure containing the central canal. The grey matter of the cord is divided into five areas or parts: two posterior areas or masses, the *posterior cornua*; two anterior areas, the *anterior cornua*; a median part, the grey commissure, continuous at each side with the two cornua. A *lateral horn* of grey matter, projecting into the lateral column of the cord at the junction of the anterior and posterior cornua, is seen in the cervical and dorsal regions (fig. 431). In the dorsal region and extending some distance into the cervical and lumbar regions, coextensive with the origin of the white rami communicantes, there is also a special group or columnar series of nerve cells (*Clarke's column*) situated at the inner side of the posterior horn behind the grey commissure. The grey matter is increased in amount where the large nerves for the limbs arise.

The **white matter** of the cord surrounds the grey matter. The entrance of the posterior root fibres divides it into posterior and antero-lateral columns (fig. 431).

The white matter of the posterior column of the cord is made up of fibres passing from the posterior roots to (1) cells in the posterior horn; (2) cells in the nucleus cuneatus and nucleus gracilis in the corresponding column of the medulla oblongata (fig. 449, p. 342). The posterior column is a sensory pathway for nerve-stimuli passing in by the posterior roots and

Fig. 431.—Sections through different regions of the spinal cord. (*After Schwalbe, from Morris's 'Anatomy.'*)


Posterior roots
Anterior roots
A. At the level of the sixth cervical nerve-roots
Posterior fissure
Anterior fissure
B. At the mid-dorsal region
Central canal
C. At the centre of the lumbar enlargement
D. At the upper part of the conus medullaris
E. At the level of the fifth sacral nerve-roots.
F. At the level of the coccygeal nerve-roots.

ascending towards the brain and cerebellum. The posterior column begins with the entrance of the posterior roots of the coccygeal and sacral nerves; the addition of fibres from each successive pair of roots leads to the column gradually increasing in size as the medulla is approached (fig. 431).

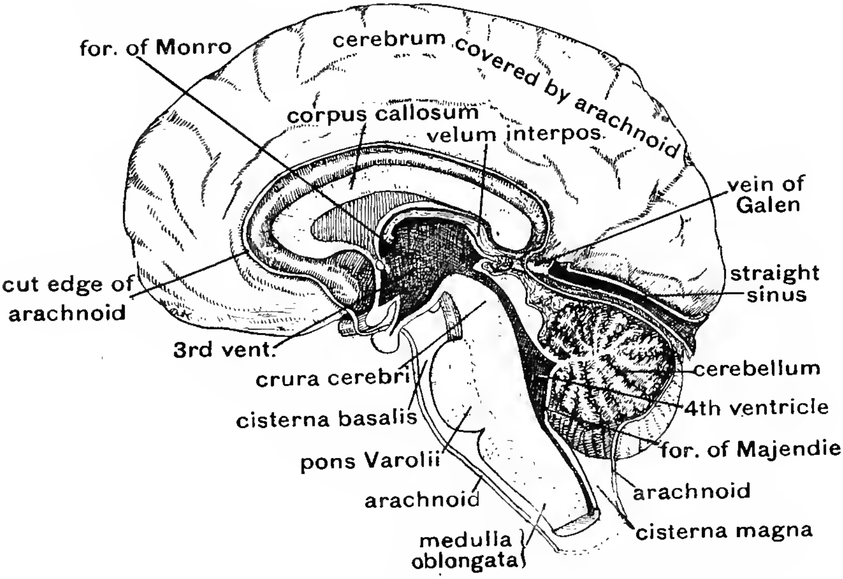
The white matter of the antero-lateral column of the cord is made up of direct and crossed pyramidal fibres (fig. 430, 10, 13); ascending and descending cerebellar tracts (fig. 430, 14, 15); and commissural fibres joining one segment of spinal grey matter with another (fig. 430, 11, 12, 16).

DISSECTION XXIII

THE BRAIN

Parts of the Brain.—Within the comprehensive title of brain are included all those parts of the central nervous system which lie within and fill the cavity of the skull. The brain varies in size, but as a rule weighs from 1,300 to 1,400 grammes (45 to 50 oz.). Seven-eighths of this great mass are formed by the cerebral hemispheres. Before commencing its dissection,

FIG. 432.—VERTICAL MESIAL SECTION OF THE BRAIN, TO SHOW (1) ITS MAIN DIVISIONS, (2) THE ARRANGEMENT OF ARACHNOID, AND (3) THE THIRD AND FOURTH VENTRICLES.



the student should distinguish the five parts which compose the brain, observing that each part is made up of a right and left half united together in the middle line (see fig. 432).

I. The CEREBRUM, made up of two hemispheres separated by the great longitudinal fissure, and united together, as may be seen by pulling them slightly apart, by the corpus callosum. The great basal ganglia of the brain are included with the cerebrum (see fig. 446, p. 336).

II. The PEDUNCLES OF THE BRAIN (CRURA CEREBRI) join the cerebrum to the next division—the Pons Varolii. The crura are best seen on the base of the brain (Plate LIV, p. 314), but they can also be seen from behind by separating the hemispheres of the cerebrum from the cerebellum.

III. The PONS VAROLII (fig. 432) connects the peduncles of the brain to the medulla oblongata, its ventral surface, composed of transverse fibres, rising prominently above the level of both the crura and the medulla.

IV. The CEREBELLUM is connected by three peduncles or strands on each side with the pons, medulla, and crura (fig. 432).

V. The MEDULLA OBLONGATA joins the pons and cerebellum to the spinal cord. It is continuous with the cord within the foramen magnum, the point at which the cord commences being marked by the appearance of the first pair of cervical nerves.

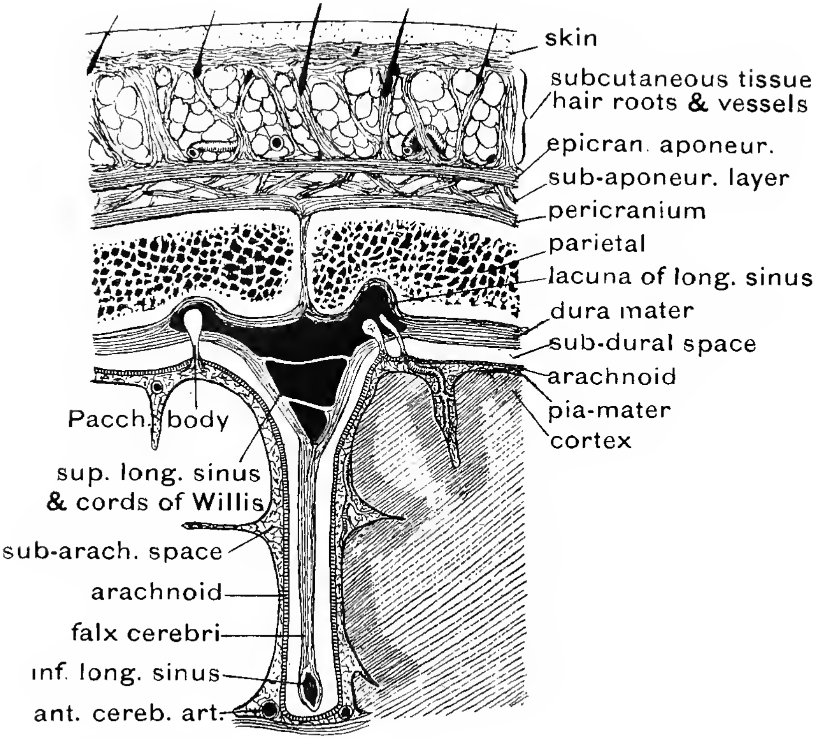
The cord, medulla, pons, and crura cerebri, besides being made up of masses of nerve cells, also contain fibre-tracts for nerve impulses passing between the cerebrum and the body.

Coverings and Membranes of the Brain.—The structures which lie superficial to the brain have been already examined (see p. 94). They are again enumerated here (see fig. 433):

(1) The scalp.
(2) The pericranium and muscles attached to the skull.
(3) The cranial bones.
(4) The dura mater.
(5) The arachnoid.
(6) The pia mater.

Arachnoid and Pia Mater.—The student should turn first to their arrangement on the LATERAL OR EXTERNAL ASPECT OF THE BRAIN. The arachnoid is so thin and transparent that the convolutions, the sulci and superficial vessels of the brain, are perfectly apparent through it. (1) If seized with a forceps it will be observed to pass from the surface of one convolution to the surface of the next without dipping into the sulci or fissures between (fig. 433): the fissure of Sylvius cannot be opened until the membrane is ruptured. (2) As it is stripped off, it will be seen to be bound to the surfaces of the convolutions by loose, fine areolar tissue which, unlike the arachnoid, dips within the sulci and fissures; to this subarachnoid tissue is given the name of PIA MATER (fig. 433). In it the cortical arteries divide and subdivide; their terminal branches can be seen to pierce and supply the cortex of the brain as the arachnoid and pia mater are stripped off together. (3) The pia mater is most abundant between the convolutions. Subarachnoid fluid occupies the spaces in the meshwork of the pia mater.

FIG. 433.—A SECTION OF THE STRUCTURES COVERING THE BRAIN.



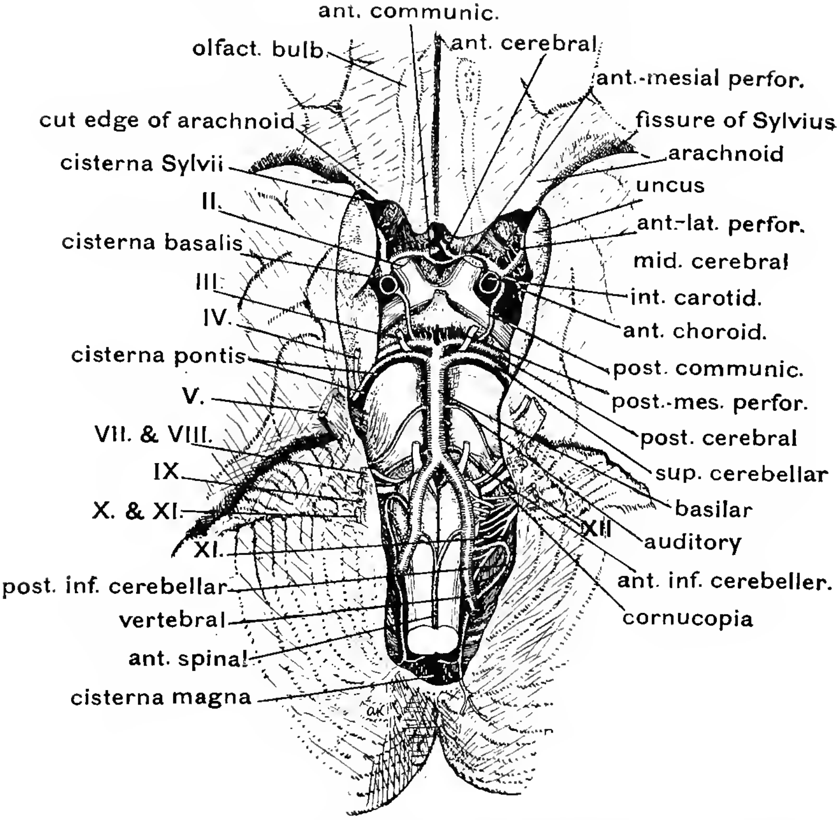
On the MESIAL SURFACE (see fig. 432) of the brain the arachnoid will be found to descend until it almost reaches the corpus callosum; it is reflected to the opposite hemisphere at the depth of the longitudinal fissure so as to leave a considerable subarachnoid space (the supra-callosal) above the corpus callosum. At the posterior end of the corpus callosum (the splenium) the arachnoid is bound firmly to veins (veins of Galen) emerging from beneath that body and passing to the straight sinus at the anterior border in the tentorium cerebelli (fig. 432). At this point, too, the cerebral arachnoid becomes continuous with the arachnoid on the upper surface of the cerebellum. The pia mater passes into the cerebral ventricles beneath the posterior end of the corpus callosum, thus forming the velum interpositum (fig. 432).

At the BASE OF THE BRAIN the arachnoid bridges over the space in which the circle of Willis lies (fig. 434). The space is the *cisterna basalis*. Into it opens the *cisterna Sylvii* on each side (fig. 434). Through the space in which the basilar artery lies (*cisterna pontis*) it communicates with the subarachnoid cavity of the cord and the cisterna magna, situated between the cerebellum and spinal canal (fig. 432).

Blood Supply of the Brain.—The brain is supplied by four arteries, the two internal carotid and the two vertebral (see figs. 434, 435). The two vertebral arteries unite together at the lower border of the pons to form the basilar artery. They supply about one-third of the total amount of blood required by the brain, and perforate the dura mater and arachnoid below the foramen magnum (fig. 384, p. 225). The internal carotid arteries perforate these membranes behind the exit of the optic nerves (fig. 413, p. 268).

The VEINS OF THE BRAIN, which should be examined before the dissection necessary to expose the arteries is undertaken, are peculiar. Small venules collect the blood from the cortex, and unite into bigger veins beneath the arachnoid. The *superior cerebral veins* on the lateral aspect of the brain pass upwards and backwards, but turn forwards as they pierce the arachnoid to enter the superior longitudinal sinus. The *inferior cerebral veins*, from the lower parts of the cortex, end in the cavernous and superior petrosal and lateral sinuses. From one of the superior cerebral veins, the *superficial communicating* of Trolard passes down to the fissure of Sylvius and ends through the superficial Sylvian vein in the cavernous sinus, or in the sinus alæ parvæ, thus establishing a communication between the sinuses on the vertex and base of the brain. The *veins* from the lower part of the occipital lobe pass directly into the lateral sinus. The veins from the interior of the brain, the *deep cerebral veins*, pass out in the velum interpositum and will be seen later (fig. 450, p. 343). A large vein, the *basilar*,

FIG. 434.—THE ARTERIES ON THE BASE OF THE BRAIN, WITH THE ORIGIN OF THE CRANIAL NERVES AND ARRANGEMENT OF ARACHNOID.



will also be found in the cisterna basalis passing from the lower end of the fissure of Sylvius, round the peduncle of the brain, to join the great vein of Galen.

Every heart-beat, by the expansion of the arteries and brain, empties the thin-walled cerebral veins into the great blood sinuses formed in the dura mater. The thick walls of these sinuses resist the intra-cranial pressure. The venous blood of the brain, except a slight amount which escapes by small emissary channels, such as the mastoid, parietal and posterior condylar, leaves the cranial cavity by the jugular foramina.

Circle of Willis (fig. 434).—Each **internal carotid** artery, as it enters the cisterna basalis, passes to the lower end of the fissure of Sylvius and divides into the MIDDLE CEREBRAL, the larger of the two terminal branches, which passes up in the depth of the fissure of Sylvius, and ANTERIOR CEREBRAL, which, turning forwards above the optic nerve, disappears in the great longitudinal fissure of the brain (fig. 434). As the internal carotid artery emerges from the cavernous sinus it gives off the ophthalmic branch and passes upwards outside the optic tract and chiasma. When the BASILAR ARTERY reaches the cisterna basalis at the upper border of the pons, it divides into right and left POSTERIOR CEREBRAL arteries. These pass backwards round the peduncles of the brain. Before dividing, each internal carotid gives off a *posterior communicating* branch to the posterior cerebral (fig. 434). A short *anterior communicating* trunk joins the two anterior cerebral arteries as they disappear in the longitudinal fissure. All the vessels just named take part in the formation of the circle of Willis.

The circle of Willis is formed by the following vessels (see fig. 435):

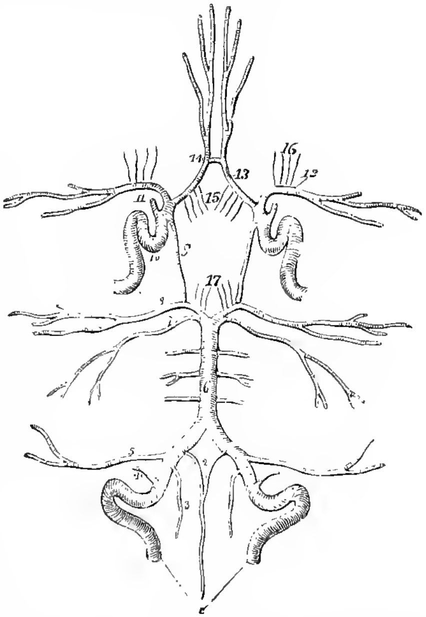
(1) The anterior communicating trunk (14).
(2) Parts of the anterior cerebral arteries (13).
(3) The terminal parts of the internal carotid arteries (10).
(4) The posterior communicating arteries (9).
(5) Parts of the posterior cerebral (8).

Through the circle of Willis the arterial pressure within these vessels is equalised; if one of the feeding arteries be occluded, the terminal parts may still be supplied through the circle. The circle lies in the cisterna basalis.

The ANTERIOR CHOROIDAL ARTERY arises from the internal carotid, near the posterior communicating artery (fig. 434). It passes backwards on the outer surface of the peduncle of the brain, and ends, as will be seen later, in the choroid plexus which projects within the ventricles of the brain.

Central, Perforating or Medullary Arteries of the Brain (see fig. 434).—From the circle of Willis and from the cerebral trunks near it, six important groups of small arteries pass directly within the brain substance, and supply the great ganglionic masses of grey matter which are situated in the basal region (fig. 454, p. 353). Two of these groups are in the middle line—the *antero-mesial* and the *postero-mesial* (fig. 435, 15, 17); four of them are lateral, two on each side, the *antero-lateral* and *postero-lateral.*

Fig. 435.—Circle of Willis. The arteries being symmetrical have references on one side only. (*Wilson.*)



1. Vertebral arteries. 2. Anterior spinal branches uniting to form a single vessel. 3. Posterior spinal artery. 4. Posterior meningeal artery. 5. Posterior inferior cerebellar artery. 6. Basilar artery giving off transverse branches. 7. Superior cerebellar artery. 8. Posterior cerebral artery (postero-lateral perforating branches omitted). 9. Posterior communicating branch of the internal carotids. 10. Internal carotid artery, showing its curves within the skull. 11. Ophthalmic artery divided across. 12. Middle cerebral artery. 13. Anterior cerebral arteries connected by— 14. Anterior communicating artery. 15. Antero-median perforating branches of anterior cerebral artery. 16. Antero-lateral perforating branches of middle cerebral artery. 17. Postero-median perforating branches of posterior cerebral artery.

The vessels of the Antero-lateral Group are by far the most important. They arise from the middle cerebral artery, and, in the natural position of the brain, pass upwards, into the substance of the corpus striatum at the anterior perforated space (see fig. 446, p. 336). One of these, the *lenticulo-striate* artery, lies at first within the grey matter of the lenticular nucleus; then, passing through the internal capsule amidst the pyramidal fibres, the highways of motor impulses, it ends in the caudate nucleus. In old people, especially in aged brain-workers, its coats are liable to disease and rupture. Hence this vessel is sometimes known as the artery of apoplexy.

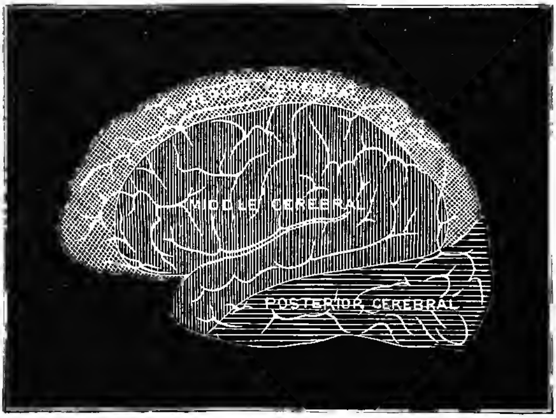
The Postero-lateral Group arises from the posterior cerebral, on the outer and posterior aspect of the peduncles of the brain. These arteries supply the peduncles and optic thalami.

The Postero-mesial Group springs from the posterior cerebral arteries at the anterior border of the pons, and perforates the grey matter in the inter-peduncular space (fig. 434).

The Antero-mesial Group pierces the grey matter in front and at the sides of the optic chiasma.

The **Middle Cerebral Arteries** will best be seen by rupturing the arachnoid and separating the lips of the fissure of Sylvius. The artery, divided into a leash of vessels, will be seen crossing the Island of Reil in the depth of the fissure. The artery supplies the Island of Reil; branches escape from the fissure and supply the convolutions on the lateral aspect of each hemisphere except those on the upper third, bordering the great longitudinal fissure, which are supplied from the anterior and posterior cerebral vessels (fig. 436). The lower part of the lateral aspect of the cerebrum is supplied by the posterior cerebral (fig. 436). Although there is an anastomosis between the branches of the middle and anterior cerebral arteries in the pia mater over the cortex, yet the communication is not sufficient to prevent widespread destruction when one or other of the two trunks is blocked by an embolus, as sometimes happens in cases of heart disease.

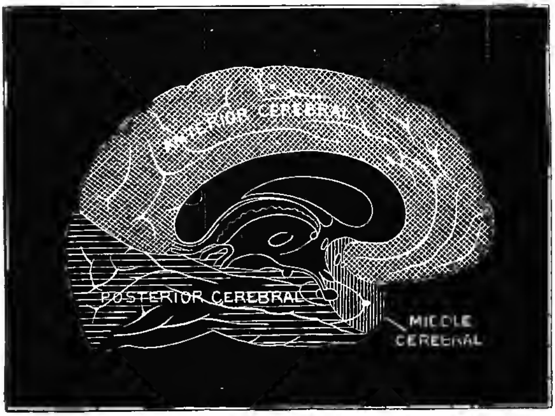
Fig. 436.—The cortical distribution of the three cerebral arteries on the external surface of the cerebral hemisphere. (*From Heath.*)



The **Anterior Cerebral Artery** passes upwards and then backwards in the great longitudinal fissure of the brain, resting on the corpus callosum and lying in the supra-callosal subarachnoid space (Plate LIII, p. 244). A terminal twig turns round the splenium of the corpus callosum and ends in the velum interpositum. The anterior cerebral arteries supply the corpus callosum, the mesial aspect of the brain above the corpus callosum, and the upper third of the lateral aspect of each cerebral hemisphere as far back as the parieto-occipital fissure (figs. 436, 437).

The **Posterior Cerebral Artery** is to be followed round the peduncle of the brain. It is hid by the overlying hippocampal gyrus. Here it gives off a *posterior choroidal* branch which ends in the velum interpositum and lining membrane of the cerebral ventricles and the postero-lateral perforating arteries to the crura cerebri and optic thalamus. Passing backwards on the lower surface of the temporo-sphenoidal lobe, within the collateral fissure, it ends in the occipital lobe which it supplies (figs. 436, 437). Branches from this artery supply the tentorial and lower part of the lateral aspect of the temporal lobe.

Fig. 437.—The cortical distribution of the three cerebral arteries on the mesial and tentorial aspects of the cerebral hemisphere. (*From Heath.*)



Blood Supply of the Cerebellum, Pons Varolii, and Medulla oblongata.

I. From the Basilar Artery (fig. 434).

(*a*) Numerous small branches (*pontine*) spring from the basilar artery, as that vessel passes forwards in the subarachnoid space beneath the pons, and enter the substance of the pons.

(*b*) Two *Superior cerebellar* arteries spring from the terminal part of the basilar, behind the posterior cerebral, each passing backwards to reach and be distributed on the upper surface of the cerebellum.

(*c*) The *Antero-inferior cerebellar* arteries pass outwards beneath the anterior parts of the lateral lobes of the cerebellum, and end between the folia.

(*d*) The *Auditory* artery arises from the basilar and passes within the internal auditory meatus. It supplies the contents of the meatus, the internal ear, and a branch passes with the facial nerve along the aquæductus Fallopii to anastomose with the stylo-mastoid artery.

II. From the VERTEBRAL ARTERY (fig. 434).

(*a*) The *Postero-inferior cerebellar* is a large and important vessel which, arising by the side of the medulla, bends inwards between the lateral lobes of the cerebellum over the roof of the fourth ventricle, to which it sends many branches (fig. 434). It ramifies between and below the lateral cerebellar lobes. It supplies the choroid plexus of the Fourth Ventricle.

(*b*) The *Bulbar arteries*, which perforate the medulla in the anterior median fissure, in front of and behind the olivary body, supply the extremely important nerve centres in the floor of the fourth ventricle.

(*c*) The *Anterior spinal* branch unites with the artery from the opposite side to form a median vessel which descends in the anterior median fissure of the spinal cord (fig. 434). It arises at the lower border of the pons.

(*d*) The *Posterior spinal* artery, which descends on the spinal cord, forming anastomotic chains in front of and behind the origin of the posterior roots of the spinal nerves (fig. 435, 3).

The CEREBELLAR VEINS end in the straight, lateral and sigmoid sinuses. The veins from the medulla join with those of the spinal cord, ultimately escaping by the vertebral and spinal veins.

CRANIAL NERVES

Origin of the Cranial Nerves (see Plate LIV).—On the basal aspect of the brain, while the circle of Willis still remains *in situ*, the points can now be examined at which the twelve pairs of cranial nerves make their exit from the brain and pass into the cavity of the arachnoid (fig. 434). Their distribution in the body has already been studied. They differ markedly in size, in importance, and in manner of origin. The Olfactory Pair (I) and the Optic (II) are really modified parts of the brain itself, and differ from the remaining ten pairs in form and structure. The Fourth and Sixth Pairs are mere twigs compared with the great trunks formed by the Fifth or Trigeminal and Tenth or Vagus.

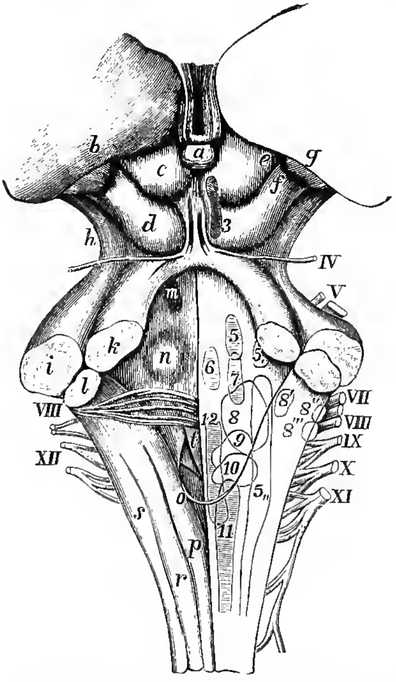
It is more convenient to commence by an examination of the more posterior cranial nerves, because the more anterior nerves require a good deal of dissection to display them properly, and the neighbouring small nerves are apt to be cleared away unnoticed. Besides, the posterior nerves present a closer resemblance to the spinal nerves in their manner of origin.

The **Hypoglossal (XII) Pair of Cranial Nerves** appears on the medulla oblongata between the pyramid and olivary bodies (Plate LIV). The ten or twelve fasciculi, which appear in line with the anterior roots of the spinal nerves, unite into two cords which perforate the arachnoid and dura mater in separate compartments. The fibres arise from grey matter in the floor of the fourth ventricle—a direct continuation upward of the grey matter of the anterior horn of the spinal cord (see fig. 468, p. 376). Where the nerve fasciculi appear in the sulcus between the pyramid and olive, they are surrounded by bulbar arteries and a dense coat of pia mater from the covering of the medulla. They leave the skull by the anterior condylar foramina.

The **Spinal accessory (XI) Pair of Cranial Nerves** consists of two parts, spinal and bulbar or accessory. The *spinal* fibres appear on the side of the cervical part of the spinal cord between the anterior and posterior roots of the five upper spinal nerves; the *bulbar* fasciculi arise from the medulla between the olivary and restiform bodies and form the accessory part of the XIth, joining the vagus outside the skull. Functionally these fibres are part of the vagus. The spinal fibres arise from the ventrolateral column of the anterior horn of the spinal cord and pass up in the foramen magnum behind the vertebral artery. The position of its centre is shown in figs. 438 and 468, p. 376.

The **Vagus (X) or Pneumogastric Nerve** appears as a closely arranged series of fasciculi between the olivary and restiform bodies (Plate LIV). The fasciculi form a continuation upwards of the spinal accessory series. The nuclei of origin lie in the floor of the fourth ventricle (see fig. 438).

Fig. 438.—Floor of fourth ventricle showing nuclei of origin of cranial nerves. (*Erb.*)



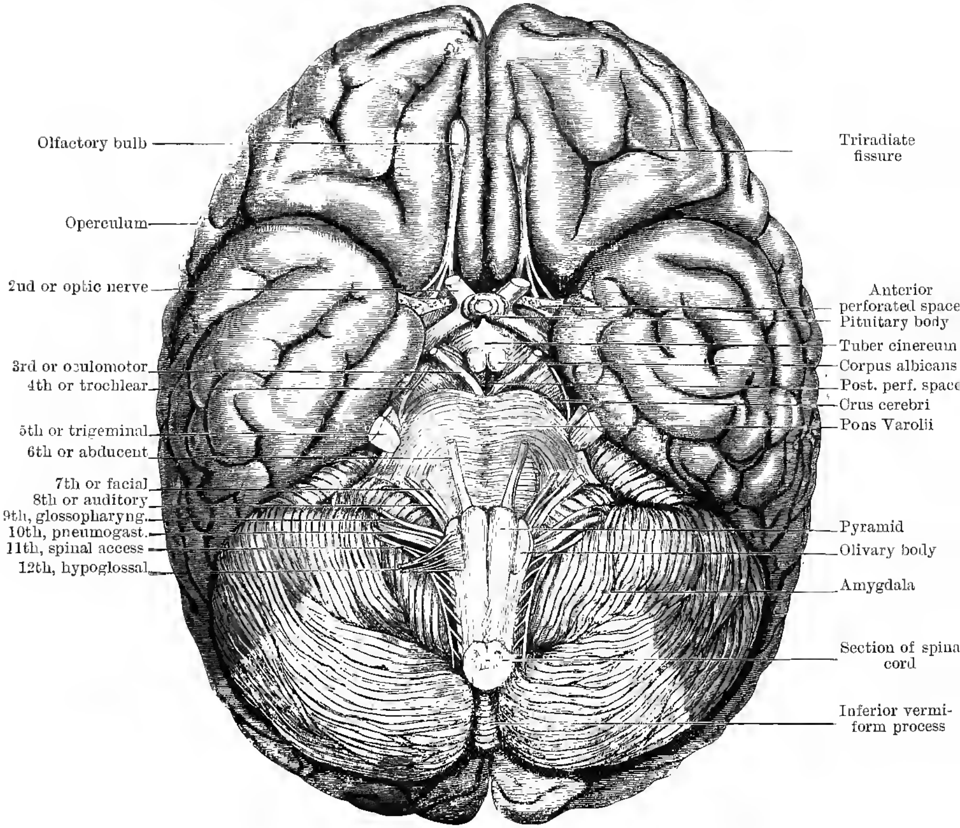
a. Pineal body. *b.* Pulvinar of optic thalamus. *c.* Anterior corpus quadrigeminum (nates). *d.* Posterior corpus quadrigeminum (testes). *e.* Anterior brachium. *f.* Posterior brachium. *g.* Internal geniculate body. *h.* Crus cerebri. *i.* Middle peduncle of crus cerebelli. *k.* Superior peduncle (processus e cerebello ad testes). *l.* Inferior peduncle (restiform). *m.* Locus cæruleus. *n.* Eminentia teres. *o.* Obex. *p.* Funiculus gracilis. *r.* Funiculus cuneatus. *s.* Funiculus of Rolando. *t.* Fasciculus teres. The nuclei of the cranial nerves are indicated by italic figures, the nerve trunks by Roman numerals.

The **Glosso-pharyngeal (IX) Nerve** also arises from nuclei in the lower half of the floor of the fourth ventricle, and emerges as six or eight filaments between the olivary and restiform bodies, continuing upwards the filaments of the vagal series, and not easily separable from them. Nerves IX, X, and XI pass from the skull by the jugular foramen. The vagus and spinal accessory perforate the arachnoid and dura mater together (fig. 434).

The **Auditory (VIII) Nerve** arises by two roots, one *dorsal* to the restiform body and the other *ventral* to it (fig. 438). Some of the nerve fibres spring from nuclei situated on the restiform body and under the auditory tubercle in the floor of the fourth ventricle (fig. 438). The nerve turns round the posterior border of the middle peduncle of the cerebellum—the lateral prolongation of the pons into the cerebellum—and passes

PLATE LIV

VIEW OF THE BASE OF THE BRAIN. (*After Beaunis.*)



directly into the internal auditory meatus, surrounded by a wide arachnoid sheath (fig. 434).

The **Facial (VII) Nerve** appears at the posterior border of the pons, at the inner side of the auditory nerve, and in front of the glosso-pharyngeal (Plate LIV). Between it and the auditory appears a small fasciculus, the PARS INTERMEDIA, which joins the facial nerve in the internal auditory meatus. The facial nucleus of origin is situated to the outer side of the eminentia teres in the upper half of the floor of the fourth ventricle, just above the striæ acusticæ (fig. 438, p. 314). The facial nerve enters the internal auditory meatus with the VIIIth and passes into the aquæductus Fallopii. It is mainly a motor nerve —for the facial muscles.

The **Sixth (VI) Nerve** is of small size, supplying only the external rectus muscle of the eyeball. It appears behind the posterior border of the pons and at the upper extremity of the pyramid. Its nucleus of origin is superficially placed in the floor of the fourth ventricle, beneath the eminentia teres (fig. 438, p. 314).

The **Fifth (V) Trifacial** or **Trigeminal Nerve** perforates the upper fibres of the pons as they pass outwards to form the middle peduncle of the cerebellum. The greater part of the nerve is made up of sensory fibres, but when these are turned outwards a small bundle of motor fibres will be found perforating separately ventral to the great sensory bundle (fig. 439). The sensory fibres, which correspond to the fibres of the posterior root of a spinal nerve, are developed from the Gasserian ganglion. The central nuclei connected with the sensory fibres of the fifth nerve are very extensive (fig. 438). They lie along the floor of the fourth ventricle, being continuous with the grey matter of the posterior horns of the spinal cord below and the grey matter in the floor of the aqueduct of Sylvius above. The widespread nature of its origin explains the great disturbance set up by diseases which affect the fifth nerve. The motor centre is situated in the grey matter of the upper part of the floor of the fourth ventricle (see fig. 438).

The **Fourth (IV)** or **Trochlear Nerve** supplies the superior oblique muscle of the eye, and is rather smaller in size than a digital nerve. It will be found passing round the peduncles of the brain between the posterior cerebral and superior cerebellar arteries (fig. 316, p. 118). Its roots have already crossed in the superior medullary velum (fig. 438). Its nucleus of origin is in the floor of the aqueduct of Sylvius.

The **Oculo-motor (III) Nerve** appears in front of the pons on the inner aspect of each cerebral peduncle, and springs forward in the cisterna basalis between the posterior cerebral and superior cerebellar arteries (fig. 434). Its origin is from nuclei situated in the floor of the aqueduct of Sylvius (fig. 438, p. 314).

DISSECTION.—Before proceeding with the examination of the optic nerves, the dissector should clear away from the basal aspect of the brain the circle of Willis and all the small vessels, with such remnants of the arachnoid and pia mater as may still remain.

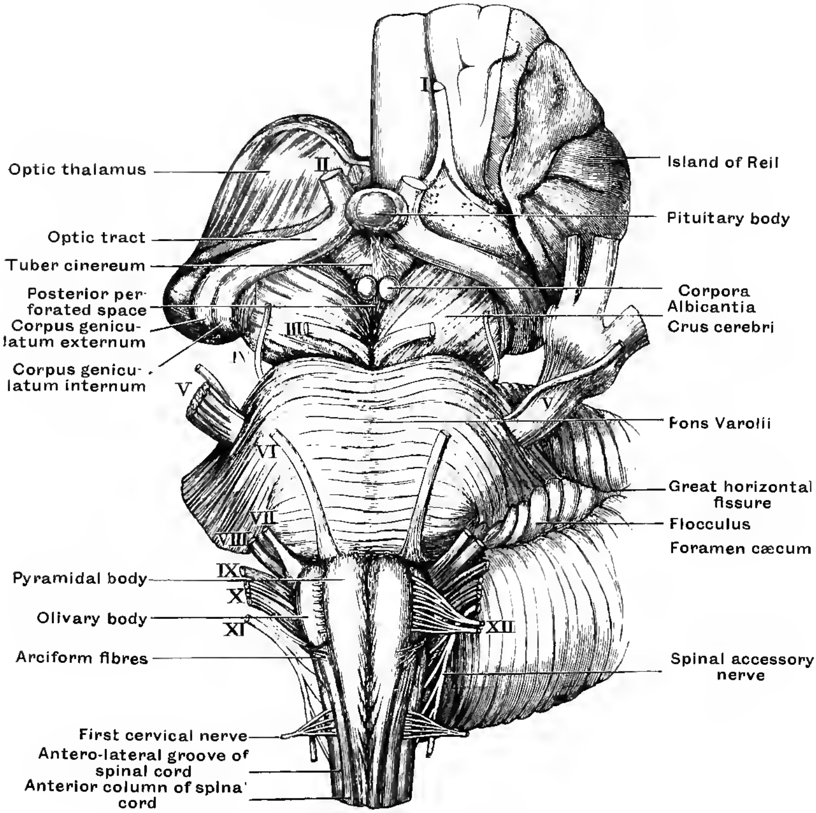
Optic Nerves, Chiasma, and Optic Tracts.—The OPTIC NERVES, as already pointed out, differ in nature from the cranial nerves just described. They were cut at their point of exit at the optic foramina, when the brain was removed (fig. 434). Their intra-cranial stage is only about 6 mm. long. They are surrounded by a sheath of pia mater and arachnoid, while a stout sheath of dura mater is added as they escape to the orbit.

The CHIASMA (Plate LIV) is the rounded transverse band at which the optic nerves terminate and at which the optic tracts commence. It is made up mainly of fibres which cross from one optic nerve to the optic tract of the opposite side. On its lower surface lie fibres (Gudden's commissure) which connect the opposite internal geniculate bodies. As the student already knows, the optic tract of the left side supplies the left sides of both retinæ, while the right supplies the right sides of both. Hence the crossing of the optic fibres and the formation of the chiasma. The chiasma is developed in a plate of grey matter which forms the floor of the third ventricle (fig. 319, p. 125). The infundibulum of the pituitary body descends behind it, and when the brain is *in situ* the chiasma rests above the olivary eminence of the sphenoid. A tumour, even a small one, situated in the pituitary region, can produce numerous lesions owing to the proximity of so many structures in this part.

The OPTIC TRACTS cannot be examined satisfactorily at the present stage of dissection. (See figs. 439, 456, p. 358.)

The **Olfactory (I) Pair of Nerves**, like the optic, differs in manner of origin from the other cranial nerves. When the frontal lobes were first raised in the process of removing the brain, the dissector will remember that the *olfactory bulb* of each side was left *in situ* on the cribriform plate while the *olfactory tract* was cut as it joined the bulb. The olfactory bulb and the olfactory nerves, which pass from the bulb to the olfactory mucous membrane within the nose, have already been examined (p. 123).

FIG. 439.—SURFACE ORIGIN OF THE CRANIAL NERVES.
(*After Allen Thomson.—Quain.*)



The Roman numerals indicate the cranial nerves.

The OLFACTORY TRACT will now be found in the sulcus olfactorius, a linear depression on the orbital surface of the frontal lobes, one on each side of the longitudinal fissure of the brain (fig. 439).

OLFACTORY ROOTS (fig. 439).—As the olfactory tract passes backwards, it divides into two roots, an inner and outer. The *outer root* crosses the anterior perforated space and ends on the inner aspect of the uncus, a convolution above the pole of the temporal lobe of the brain (fig. 453, p. 348). The *inner* root turns inwards and disappears within the longitudinal fissure of the brain. If the fissure be pressed gently open, the root will be seen to ascend towards the rostrum of the corpus callosum. Some of its fibres pass backwards as longitudinal striæ on the corpus callosum and end in the hippocampal gyrus, while others pass backwards in the fornix (see fig. 453, p. 348).

Olfactory Trigone.—Between the roots of the olfactory tract there is a triangular area of grey matter, separated from the anterior perforated space by a transverse fissure (fig. 439). To this the name of olfactory trigone is given.

The grey matter of the anterior perforated space, in which the antero-lateral group of cerebral arteries have been seen to enter the brain, should also be included in the olfactory areas. The olfactory bulb, the tract, roots, trigone, and grey matter of the anterior perforated space are all developed from the olfactory lobes of the embryonic brain, and are therefore, in contrast to the cranial nerves, essentially parts of the brain and connected with the sense of smell.

THE CEREBRUM

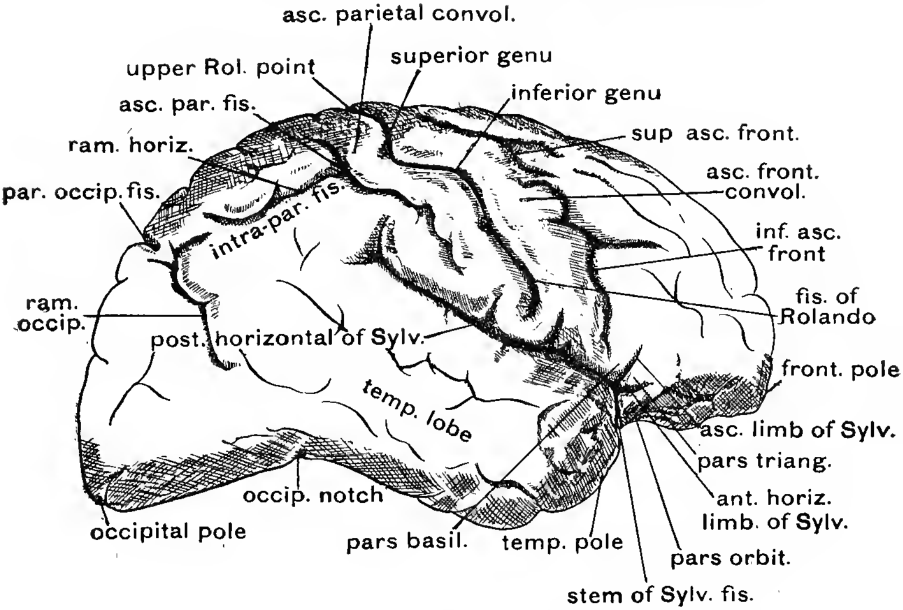
For purposes of description it is a matter of convenience to speak of the posterior end of the cerebrum as the *occipital pole*, the anterior as the *frontal pole*, and the tip of the temporal lobe as the *temporal pole* (see fig. 440).

The **Cerebrum,** the lateral (external or calvarial) aspect of which is to be examined first, is made up of two hemispheres; the corpus callosum crosses the great longitudinal fissure and joins them; the peduncles of the brain (mesencephalon) unite the hemispheres to the pons and cerebellum (fig. 432, p. 303). The student should not forget that a structure very similar to the one before him is building up his present visual picture. The movement he makes with his hand is initiated within a cortical area he may now examine.

The **Sensori-motor Areas of the Brain** lie on the lateral aspects of the hemispheres. The arachnoid, pia mater, and vessels must be cleaned away from the surface of the *convolutions* and from the *sulci*, which separate the convolutions.

Running obliquely downwards near the middle of the lateral aspect of the hemisphere, there are three fissures or deep depressions (fig. 440), which, in spite of their irregularities and breaks, are nearly parallel to each other, and about three-quarters of an inch apart. The middle of the three is the FISSURE OF ROLANDO or CENTRAL FISSURE ; the one in front of it, usually separated into fragments, is the ASCENDING FRONTAL or PRECENTRAL FISSURE ; the one behind it, usually divided into an upper and lower part, is the ASCENDING PARIETAL or POST-CENTRAL FISSURE. Between these three fissures lie two convolutions : the posterior one is the ASCENDING PARIETAL ; the anterior, the ASCENDING FRONTAL (fig. 440). These two, with parts of the convolutions in front of the ascending frontal, are the areas in which the sensory impulses from the body seem to come into consciousness, and where voluntary movements are propagated and regulated.

FIG. 440.—THE CENTRAL OR SENSORI-MOTOR REGION OF THE CEREBRUM.



Convolutions, Sulci, and Fissures.—The minor elevations on the surface of the brain are known as *convolutions* ; the linear depressions which separate them are the *sulci*. The convolutions are grouped into *lobes*; the main depressions which separate or divide lobes are known as *fissures*. Without damaging his part, the student may, by a couple of incisions across the upper part of the fissure of Rolando and ascending convolutions, raise a thin wedge-shaped piece, which will make clear to him the manner in which the grey and white matter are formed into convolutions. The excised wedge must be one inch deep at least, so as to insure a complete section of the fissure of Rolando. On the surface of the convolutions he will see the grey matter, which contains pyramidal and other nerve cells and forms a layer 3 to 5 mm. ($\frac{1}{8}$ to $\frac{1}{5}$ inch) deep. The grey matter of one convolution is continuous at the bottom of the sulci and fissures with that of the next, so that the entire surface of each cerebral hemisphere is coated with a continuous layer of grey matter. The grey matter forms the cortex of the convolution—the *cortex of the brain.* The *medulla* or centre of each convolution is made up of white matter—nerve fibres proceeding in every direction, but most of them streaming inwards or outwards from the cortex to the centre of the brain. Some of these fibres are the pyramidal, which pass from the nerve cells in the cortex of the motor convolutions down to the spinal cord. It will be thus seen that by convoluting or throwing into folds the surface of the brain a much larger superficies of grey matter is obtainable than if the surface were flat or even.

The **Fissure of Rolando** (fig. 440) is about three and a quarter inches long; when the convolutions are parted it is seen to be about three-quarters of an inch deep, but its depth varies; its deepest parts are in the upper and lower thirds. Two GENUA or bends divide it into three parts; the convexity of the *upper bend* or *genu* is directed backwards, that of the lower forwards; the fissure is thus divided into three parts, the *supra-geniculate*, the *intra-geniculate*, and *infra-geniculate.* The areas in front of and behind the intra-geniculate part are concerned with the movements of the arm and hand; the body and leg areas lie in front of and behind the supra-geniculate segment; the face, mouth, and tongue areas lie on each side of the infra-geniculate part.

As a rule the fissure of Rolando reaches the Great Longitudinal fissure, but stops short of the fissure of Sylvius below. On many brains, however, the extremities are prolonged so as to reach both fissures. The fissure of Rolando is the boundary line between the frontal and parietal lobes of the brain; the student will note that, although this manner of demarcating the brain is convenient for descriptive purposes, it has the drawback of assigning the anterior part of the sensori-motor areas to the frontal lobe and the posterior to the parietal lobes; whereas from a functional point of view they form a united area. The manner of indicating the position of the fissure of Rolando on the surface of the head has already been given (see fig. 302, p. 92).

The **Fissure of Sylvius** (fig. 440) should now be examined. The membrane should be cleaned from the convolutions which bound the fissure, its lips or opercula parted, and the pia mater and middle cerebral arteries removed from its floor. When its OPERCULA (bounding convolutions) are well separated, the Island of Reil, a pyramidal convoluted mass of cortex, is seen to project from its floor (fig. 441).

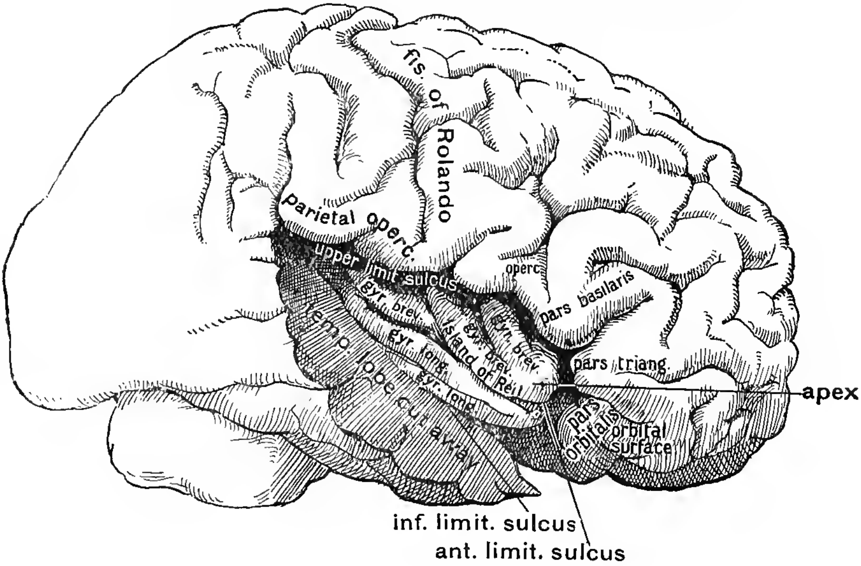
It is not possible to quite grasp the nature of the fissure of Sylvius without a reference to the manner in which it appears on the fœtal brain. If the student will examine the unconvoluted cerebrum of a fifth-month human fœtus he will see that a triangular area on the lower lateral aspect, having its base directed forwards and its apex backwards, is becoming sunk by the upgrowth of the cortex round it. The triangular depressed area becomes the Island of Reil. Three grooves or *limiting sulci* bound the insular area (fig. 441); the *anterior* separates it from the orbital part of the frontal lobe; the *lower* limiting sulcus separates it from the temporal lobe; the *upper* separates the rising cortex of the frontal and parietal lobes from the insular triangular area. By the time of birth the orbital, fronto-parietal, and temporal areas have grown up, and formed lips or opercula which completely cover in the Island of Reil. The anterior or orbital lip is frequently subdivided (fig. 441), and hence, where the opercula meet to form the fissure of Sylvius, it has the form shown in fig. 440. Four parts are recognised in the fissure (fig. 440):

(1) The stem.
(2) The anterior horizontal limb.
(3) The anterior ascending limb.
(4) The posterior horizontal limb.

(1) The STEM separates the temporal lobe of the brain from the orbital part of the frontal lobe. When the brain is *in situ*, the small wing of the sphenoid fits within the valleculus over the stem of the fissure and above the temporal pole. Through the stem the middle cerebral artery enters the floor of the fissure of Sylvius (fig. 434, p. 307). The anterior perforated space lies at the inner end of the stem.

(2) The ANTERIOR HORIZONTAL LIMB, especially on the right side, is often absent. It lies between the two parts of the orbital operculum.

FIG. 441.—THE ISLAND OF REIL EXPOSED. (*Alfred Billinghurst.*)



(3) The ANTERIOR ASCENDING LIMB is formed at the upper anterior angle of the Island of Reil by the orbital operculum coming in contact with the anterior end of the fronto-parietal operculum. As a rule it is less than one inch in length.

(4) The POSTERIOR LIMB is three inches in length and is formed by the meeting of the temporal and fronto-parietal opercula over the Island of Reil. The fissure, therefore, separates the frontal and parietal lobes above from the temporal lobe below (fig. 442). The posterior extremity of this limb, however, lies within the parietal lobe itself; the convolution

which surrounds its upturned extremity is the supra-marginal gyrus of the parietal lobe (see fig. 442).

The directions for indicating the positions of the various parts of the fissure of Sylvius on the head have already been given (see fig. 302, p. 92).

The **Parieto-occipital Fissure** (figs. 440, 443) separates the parietal lobe in front from the occipital lobe behind. The fissure indents the inner or mesial aspect of the hemisphere; it is only the upper extremity of the fissure (external parieto-occipital) which is seen on the outer aspect of the brain. It will be described more fully when the mesial aspect of the brain is dealt with.

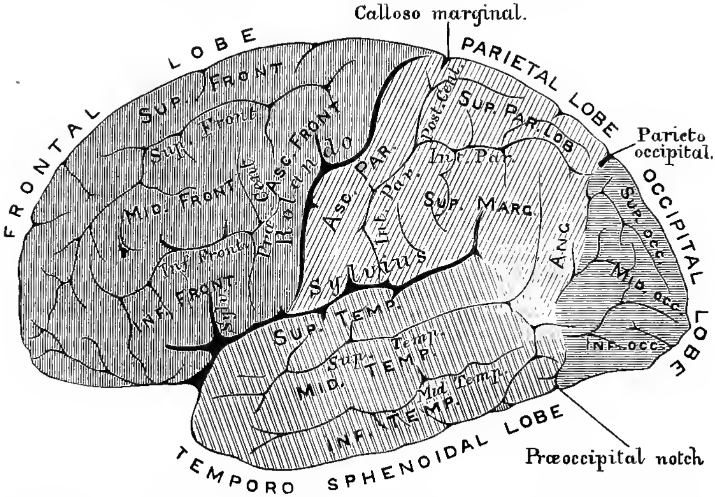
The **Ramus Occipitalis of the Intra-parietal Fissure** (see fig. 440), a vertical furrow on the outer surface of the hemisphere, situated rather behind the line of the parieto-occipital fissure, separates the comparatively small outer surface of the occipital lobe behind from the much larger parietal lobe in front. It is inconstant in depth and length.

Lobes of the Brain.—It will be seen that the convolutions on the *outer* or *lateral* aspect of each hemisphere are divided into five areas or lobes by means of the fissures just described (fig. 442):

1. The ISLAND OF REIL or INSULAR LOBE, buried within the fissure of Sylvius (fig. 441).
2. The FRONTAL LOBE, which includes the convolutions in front of the fissure of Rolando.
3. The OCCIPITAL LOBE, comprising the convolutions behind the parieto-occipital fissure and the ramus occipitalis of the intra-parietal fissure (fig. 442). The præ-occipital notch, caused by one of the inferior cerebral veins, marks on the lower border of the hemisphere the union of the occipital and temporal lobes (fig. 442).
4. The PARIETAL LOBE, between the fissure of Rolando in front and the parieto-occipital and ramus occipitalis behind.
5. The TEMPORAL (temporo-sphenoidal) LOBE includes all on the lateral aspect below the anterior three-fourths of the fissure of Sylvius. This lobe fuses behind with, and is not strictly separable from, the occipital and parietal lobes.

Mesial and Tentorial Aspects of the Brain (figs. 443 and 445).—To see the inner or mesial aspect and the surface which rests on the tentorium cerebelli, which is continuous with the mesial aspect, it would be necessary to completely separate one hemisphere from the other. It is not advisable that any degree of force should be used in separating the hemispheres of the brain at this stage of its dissection, but by pulling on them gently the student will be able to pick away the arachnoid and pia mater from the convolutions and sulci of the mesial and tentorial aspects, and at any rate recognise the position of the lobes and fissures. To see these clearly he ought to have a mounted or 'store' specimen before him, such as is shown in fig. 443, on which to verify the following description.

FIG. 442.—LATERAL VIEW OF THE CONVOLUTIONS OF THE BRAIN. (*Anderson, after Thane, in Heath's 'Anatomy.'*)



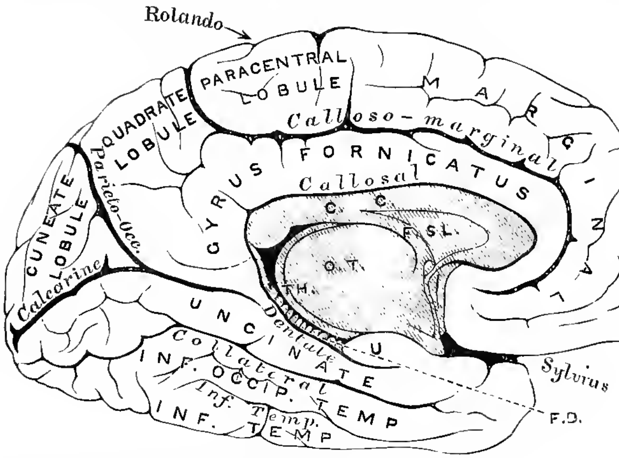
The references to the Convolutions and the Sulci are distinguished by differences in type. The convolution in the fore part of the occipital lobe behind the angular is now called the post-parietal.

On the **mesial surface** of the brain the following fissures should be recognised:

(1) CALLOSO-MARGINAL (fig. 443).—It begins on the inner surface of the frontal lobe below the corpus callosum, and, sweeping round at some distance from the anterior extremity of that body, passes backwards and separates the cortex on the mesial aspect into an outer or MARGINAL gyrus and an inner or CALLOSAL gyrus (gyrus fornicatus). Some distance in front of the parieto-occipital fissure and behind the termination of the fissure of Rolando, the calloso-marginal fissure turns upwards

and ends at the upper margin of the mesial surface. The greater part of the marginal gyrus belongs to the frontal lobe ; only a small posterior part, that behind the termination of the fissure of Rolando, belongs to the parietal lobe. A quadrate area—the PRECUNEATE gyrus (quadrate lobule)—in front of the parieto-occipital fissure and behind the termination of the calloso-marginal, also belongs to the parietal lobe. A slight sulcus, continuing the line of the calloso-marginal fissure, separates the precuneate gyrus above from the callosal gyrus below. That the marginal gyrus belongs to the frontal and parietal lobes is shown by the fact that, when suitably stimulated during life, it gives rise to definite movements in the body and limbs. It belongs, in part at least, to the sensori-motor area of the brain.

Fig. 443.—The inner and tentorial surfaces of a cerebral hemisphere showing the convolutions and sulci. (*Anderson, after Thane; in Heath's 'Anatomy.'*)



C. C. Corpus callosum. S. L. Septum lucidum. F. Fornix. O. T. Optic thalamus. T. H. Tænia hippocampi. F. D. Fascia dentata.
The convolutions and sulci are distinguished by differences in type.

(2) The Parieto-occipital Fissure (fig. 443) is a vertical indentation on the inner aspect of the brain, separating the mesial surfaces of the parietal and occipital lobes. Its upper extremity is seen on the lateral aspect of the brain, indenting the upper margin ; its lower extremity terminates in the calcarine fissure (fig. 443).

(3) The Calcarine Fissure (fig. 443) begins behind, often in a T-shaped sulcus, on the inner aspect of the occipital pole,

and passing forwards ends on the tentorial surface of the cerebrum below the posterior extremity (splenium) of the corpus callosum. The internal parieto-occipital fissure joins it, and between them is cut off a triangular area on the mesial surface of the occipital lobe—the CUNEATE GYRUS or LOBULE. The calcarine fissure is very deep ; several buried or annectant gyri cross its floor ; the optic radiation ends in its cortex ; the convolutions bounding it are closely connected with the sense of sight.

(4) The CALLOSAL FISSURE (fig. 443) separates the callosal gyrus from the corpus callosum. It is shallow.

Fissures on the Tentorial Aspect of the Brain.—A rounded ridge below the calcarine fissure marks the junction of the tentorial and mesial aspects of the brain.

(1) The COLLATERAL FISSURE (fig. 443) commences on the tentorial surface below the calcarine fissure and, running parallel to it, passes forwards to end on the inner aspect of the temporal pole. Its anterior part is commonly broken up and irregular. Towards the posterior end its depth is considerable. It separates the temporal lobe of the brain from the hippocampal or uncinate gyrus above the fissure.

It will be thus seen that parts of the frontal, parietal, and occipital lobes appear on the mesial surface of the brain and of the temporal lobe on its tentorial aspect. As on the lateral aspect, the temporal lobe fuses behind with, and cannot be distinctly demarcated from, the occipital lobe. It would be well to include with the occipital lobe all of that part of the tentorial surface which lies below or external to the calcarine fissure and behind the line of the parieto-occipital.

Limbic Lobe.—The limbic lobe is made up of two convolutions or gyri : (1) the callosal (gyrus fornicatus), (2) the hippocampal or uncinate. This is how Broca, who described it first, defined it, but many vestigial parts of the cortex have been added to it. Recent research, however, has shown the advisability of returning to Broca's original definition.

The CALLOSAL GYRUS or GYRUS FORNICATUS lies above the corpus callosum, and is separated from the frontal and parietal lobes by the calloso-marginal fissure and the sulcus which continues backwards the line of that fissure (fig. 443). It bends round the anterior extremity (the genu) of the corpus callosum, and also round its posterior extremity (the splenium).

The HIPPOCAMPAL or UNCINATE GYRUS is continuous behind the splenium with the callosal gyrus, and passes forwards above the collateral fissure to end in an enlargement (the uncus) situated above the temporal pole (fig. 443). This gyrus appears to be devoted to the senses of smell and taste. The incisura temporalis separates the uncus from the pole of the temporal lobe (fig. 453, p. 348).

SUMMARY OF THE LOBES.—Thus it has been seen that the cortex of each hemisphere is divided into six areas or lobes. Four of these, viz. the Frontal, Parietal, Occipital, and Temporal, appear on the external surface; and one, viz. the Insular lobe, is buried in the fissure of Sylvius. On the mesial or tentorial are found (1) the Limbic, (2) parts of the Frontal, Parietal, Occipital, and Temporal.

Rhinencephalon.—There is a seventh lobe, however, which is made up of quite a peculiar part of the cortex. For the greater part, if not entirely, it is developed in connection with the sense of smell. It represents in the evolution of the vertebrate brain the very first parts to appear. In man, it can be readily understood, this lobe, which constitutes such a large part of the low vertebrate brain, has been broken up and reduced to a number of vestigial remnants. These cannot be well examined at the present stage of the dissection, and must be deferred to a later stage (see p. 347 and fig. 453).

The Gyri and Sulci of Each Lobe.—Having thus gained a general conception of the six parts or lobes into which the cortex of the brain is divided, the dissector should now turn again to his own part and examine the various convolutions in each lobe.

Gyri or Convolutions of the Frontal Lobe.—There are three surfaces on the frontal lobe: (1) *External* or *Calvarial*; (2) *Inferior* or *Orbital*; (3) *Mesial*.

(1) ON THE EXTERNAL SURFACE (fig. 442):

(*a*) The *Ascending Frontal* or *Precentral Gyrus*, in front of the fissure of Rolando or Central fissure. The gyrus is demarcated in front by the *ascending frontal* or *precentral sulcus*, which commonly shows a separation into an upper and lower segment. The lower segment or *inferior precentral sulcus* bends forward to end in the middle frontal convolution. The upper segment or *superior precentral sulcus* represents a T-shaped piece of the superior frontal sulcus.

(*b*) The *Superior* or *First Frontal Gyrus* passes from the ascending frontal sulcus behind to the frontal pole of the brain. It lies between the great longitudinal fissure above and the superior frontal sulcus below. The *superior frontal sulcus* is broken up into three or four parts, the posterior part being continuous with the superior precentral sulcus. A series of minor sulci, which may be mistaken for the superior frontal, subdivide the superior convolution into upper and lower parts.

(*c*) The *Middle* or *Second Frontal Gyrus* is separated from the last by the superior frontal sulcus; it is separated from the next by the *inferior frontal sulcus.* The inferior part of the ascending sulcus terminates in this gyrus. The middle frontal gyrus is subdivided by minor longitudinal sulci. The posterior extremities of the upper and middle frontal gyri belong to the sensori-motor areas (fig. 440).

(*d*) The *Inferior* or *Third Frontal Gyrus* (fig. 442) is better developed on the left than on the right side of the brain, except in left-handed people, in whom the opposite is true. Broca, it is commonly said, was the first to show that this area of the brain on the left side was concerned in speech, and by many it is still spoken of as Broca's convolution. It is imperfectly separated from the second or middle frontal convolution above, and merges in the orbital surface below. The ascending and anterior horizontal limbs of the fissure of Sylvius subdivide it into three parts, which form opercula or lids over the Island of Reil (fig. 440). The part situated between the two Sylvian limbs is the *pars triangularis*; that between the ascending limb and the ascending frontal convolution, the *pars basilaris*; the part between the pars triangularis and the orbital surface, the *pars orbitalis* (fig. 441).

The external surface of the frontal lobe is thus subdivided into four parts, the Ascending, Superior, Middle, and Inferior Frontal Gyri or Convolutions.

(2) The ORBITAL SURFACE of the Frontal Lobe rests on the roof of the corresponding orbit. The arrangement of sulci is extremely variable, but the following parts can usually be defined (fig. 444):

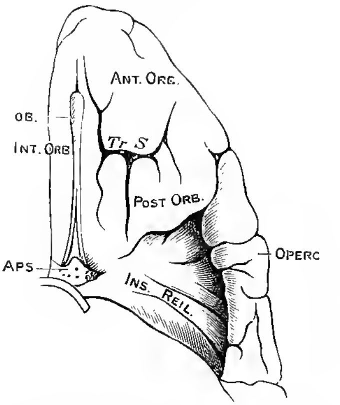
(*a*) The *Gyrus Rectus*, between the sulcus rectus (olfactory sulcus, containing the olfactory tract) and the longitudinal fissure.

(*b*) An irregular *triradiate sulcus* subdivides the remainder of the orbital surface into three districts : an anterior continuous with the superior frontal, an external with the middle frontal, and a posterior with the inferior frontal convolution.

(3) The Mesial Surface shows only the long curved *Marginal Gyrus* (fig. 443). This is separated from the callosal gyrus by the calloso-marginal fissure ; at the margin of the longitudinal fissure it is continuous with the superior and ascending frontal convolutions. Short longitudinal sulci subdivide it. The posterior third of the marginal gyrus is distinguished as the *paracentral lobule.* The part behind the upper Rolandic point is, strictly speaking, part of the parietal lobe.

Fig. 444.—Orbital surface of the frontal lobe, and island of Reil. (*Anderson, after Turner.*)

(The tip of the temporal lobe is removed.)



Tr. s. Triradiate sulcus. Ant. orb. Anterior orbital gyrus. Int. orb. Internal orbital gyrus. Post. orb. Posterior orbital gyrus. Operc. Operculum. Ob. Olfactory bulb occupying the olfactory sulcus. Aps. Anterior perforated spot. Ins. Reil. Island of Reil with its three limiting sulci.

The **Parietal Lobe** has only two surfaces, viz. (1) Calvarial or External ; (2) Mesial.

1. Gyri or Convolutions of the External Surface.

(*a*) The *Ascending Parietal* or *Post-central Gyrus* is situated behind the fissure of Rolando (fig. 442). The *ascending parietal* or *post-central fissure,* usually subdivided into upper and lower segments, separates the gyrus imperfectly from the rest of the parietal lobe. The lower segment of the ascending parietal is part of the Intra-parietal Fissure.

(*b*) The *Superior Parietal Gyrus* or *Lobule* (fig. 442) is continuous in front with the upper extremity of the ascending parietal convolution. A gyrus, which bounds the parieto-occipital fissure, joins the superior parietal to the occipital lobe. The superior parietal gyrus lies between the great longitudinal fissure above and the horizontal part (ramus horizontalis) of the intra-parietal fissure below (fig. 440). It is subdivided by minor indentations and sulci. The anterior part of this gyrus belongs to the sensori-motor areas.

(*c*) The *Supramarginal Gyrus* or *Convolution* (fig. 442) is

∩-shaped and surrounds the termination of the posterior horizontal limb of the fissure of Sylvius. By its anterior extremity it is continuous above the fissure of Sylvius with the ascending parietal convolution; its posterior extremity ends in the angular and first temporal convolutions.

(*d*) The *Angular Gyrus* (fig. 442) surrounds the termination of the superior temporal fissure. Anteriorly it is united to the supra-marginal; posteriorly it is continuous with the convolution described next. The higher visual centres have their seat in this convolution.

(*e*) The *Post-parietal* convolution includes an area variable in size, between the angular convolution in front and the ramus occipitalis of the intra-parietal fissure behind. It surrounds the termination of the second temporal sulcus. It may not be demarcated, as in fig. 442.

The outer surface of the parietal lobe is thus subdivided into five convolutions or parts—the ascending parietal, superior parietal, supra-marginal, angular, and post-parietal convolutions; and the separation is effected principally by the intra-parietal fissure.

The **Intra-parietal Fissure** is composed of four parts or rami (fig. 40). These are:

(*a*) The *ramus ascendens inferior* (inferior part of the post-central or ascending parietal fissure) separates the ascending parietal convolution from the supra-marginal.

(*b*) The *ramus ascendens superior* (superior part of the post-central fissure) may or may not be continuous with the last; it lies between the upper part of the ascending parietal convolution and the superior parietal.

(*c*) The *ramus horizontalis* may be continuous with one or both of the two parts just described, or with neither. Its posterior extremity may reach or fall short of the ramus occipitalis. The ramus horizontalis separates the superior parietal above from the supra-marginal, angular, and post-parietal convolutions below.

(*d*) The *ramus occipitalis* (fig. 440) is the imperfect boundary between the parietal and occipital lobes on the external aspect of the brain. It is variable in depth and length; it descends on the lateral aspect of the brain behind the line of the parieto-occipital fissure. An anterior branch may connect it with the ramus horizontalis.

2. On the MESIAL ASPECT of the Parietal Lobe two gyri are seen (fig. 443):

(*a*) The posterior extremity of the marginal gyrus.

(*b*) The Precuneate Gyrus or *quadrate lobule*, bounded behind by the parieto-occipital fissure and in front by the termination of the calloso-marginal.

The **Occipital Lobe,** like the Frontal, has three surfaces, viz.: (1) External, (2) Mesial, (3) Inferior or Tentorial.

1. On the EXTERNAL ASPECT (fig. 440) the occipital lobe shows several sulci, but their arrangement is irregular, so that it is better to regard the whole of this surface as parts of a single gyrus. The ramus occipitalis of the intra-parietal fissure, frequently simulated by one or two sulci on the occipital surface, bounds the gyrus in front. Round the upper extremity of the ramus occipitalis the occipital cortex becomes continuous with the superior parietal, at the lower extremity of the ramus with the post-parietal, second and third temporal convolutions.

2. On the MESIAL ASPECT (fig. 443) the occipital lobe shows only one gyrus, the *Cuneate*. The parieto-occipital fissure bounds it in front, the calcarine below. It is subdivided by minor sulci.

3. The TENTORIAL ASPECT of the occipital lobe is continuous with the corresponding surface of the temporal lobe, and there is no natural demarcation between the two. On this aspect of the occipital lobe the collateral fissure and inferior temporal sulcus end. Between the calcarine and collateral fissures is seen the *Gyrus lingualis*; between the collateral fissure and the inferior temporal sulcus, the posterior end of the occipito-temporal convolution. The posterior end of the inferior temporal convolution also appears on the tentorial aspect of the occipital lobe (fig. 443).

The **Temporal Lobe** has two convoluted surfaces, viz.: External and Inferior or Tentorial.

1. GYRI ON THE EXTERNAL SURFACE.

(*a*) The *Superior* or *First Temporal Gyrus* (fig. 442) bounds the fissure of Sylvius below, forming the temporal operculum of the Island of Reil. It is separated from the second gyrus by the first temporal sulcus or parallel fissure—one of the earliest to appear on the fœtal brain. The middle part of the convolution contains the higher auditory centres;

the convolution is continuous behind with the supra-marginal and angular gyri.

(*b*) The *Second Temporal Gyrus* lies between the first and third gyri, and is continuous posteriorly with the angular and post-parietal gyri. The second temporal sulcus is broken into three or four parts.

(*c*) The *Third Temporal Gyrus* lies partly on the lateral and partly on the tentorial aspect. It rests on the roof of the external auditory meatus and roof of the tympanum. All three gyri commence at the temporal pole, which occupies the recess under the small wing of the sphenoid in the middle fossa of the skull.

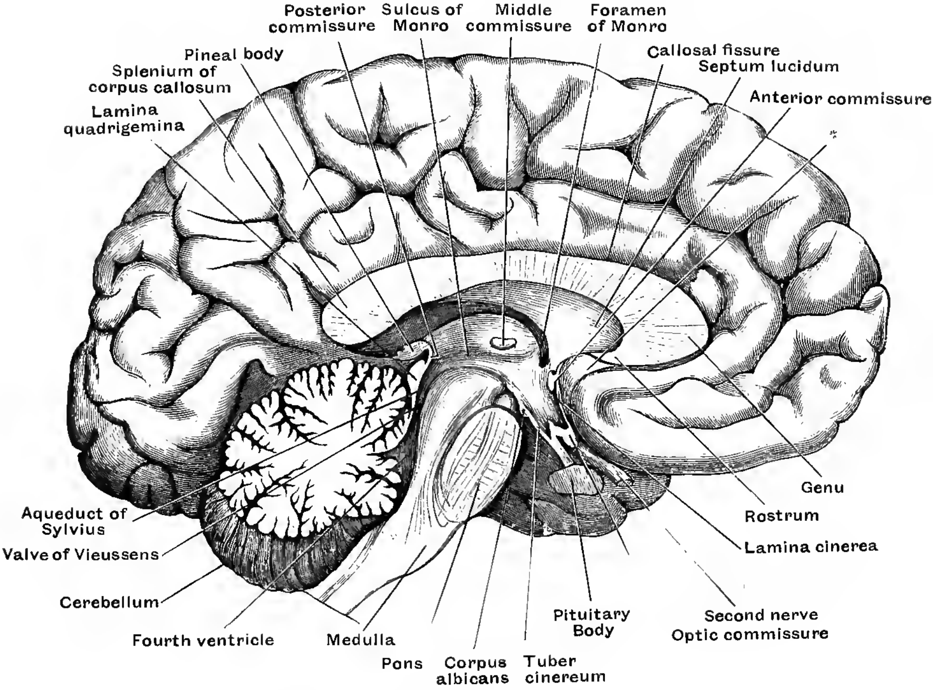
2. The TENTORIAL SURFACE shows part of the third and the whole of the occipito-temporal or *fourth temporal gyrus*. The fourth gyrus is continued behind to the tentorial surface of the occipital lobe (fig. 443) and ends in front in the temporal pole. It is separated from the uncinate gyrus by the collateral fissure, from the uncus by the *incisura temporalis*, and from the third temporal convolution by the irregular series of sulci forming the third temporal. The area of cortex between the collateral and calcarine fissures is named the *lingual gyrus*.

Gyri or Convolutions of the Insular Lobe or Island of Reil.—To see the Island of Reil, the opercula formed by the frontal, parietal, and temporal lobes must be pared away until the three *limiting sulci* which bound the triangular base of the pyramidal Insular Lobe are exposed (fig. 441, p. 322).

As a rule there are five minor gyri on the insular Lobe: two long narrow ones behind and below (*gyri longi*), lying in the line of the fissure of Sylvius, and three, sometimes four, short ones (*gyri breves*) in front, set in the direction of the fissure of Rolando. The *central sulcus* separates the three short from the two long gyri. The Island of Reil, as will be seen better at a later stage of dissection, is the cortical cap of the great basal ganglia of the brain.

Examination of a Vertical Section of the Brain in the line of the Great Longitudinal Fissure.—In the natural course of dissection the student would now proceed to examine the interior of the brain, by a series of horizontal sections. Before proceeding to do this he will find it highly profitable to examine a vertical section of the brain, of which there are always a number at hand, made in the line of the great longitudinal fissure. Such sections are shown in figs. 445 and 432, p. 303. By making this preliminary examination he will come to know the position and relations of the chief deep structures of the brain, and will then be in a more satisfactory position to proceed with the dissection necessary to expose them. He will find it convenient to have such preparations by him as are shown in figs. 446 and 454.

Fig. 445.—Mesial section of entire brain. (*After Henle.*)
The * points to the subcallosal gyrus; above it is the basal white commissure.



The chief structures which he should recognise in a vertical sagittal section are dealt with in the following paragraphs. They are:

1. The Corpus Callosum;
2. The Fornix;
3. The Septum Lucidum;
4. The Gyrus Dentatus;
5. The Dentate Fissure;
6. The termination of the Crura Cerebri;
7. The Third Ventricle.

The **Corpus Callosum** (fig. 445).—The cut surface of the corpus callosum, as seen on a mesial section of the brain, gives the student a good preliminary conception of its position and relationship. The area of its cut surface gives an indication of the enormous number of nerve fibres which compose it and join the two hemispheres of the brain together. The distance from the anterior extremity or *genu* of the corpus callosum to the frontal pole is much less than the distance from its hinder extremity or *splenium* to the occipital pole. The mass of fibres between the genu and splenium make up the body of the corpus callosum; below the genu the fibres are arranged in a thin lamina, which descends downwards and backwards and ends in the lamina cinerea, some distance above the chiasma. To this part the name of *rostrum* is given.

The **Fornix** (fig. 453, p. 348).—Only the *body* of the fornix is in contact with the under surface of the corpus callosum. Its two *anterior pillars*, passing forwards apart, curve downwards and backwards to terminate in the corpora albicantia (corpora mammillaria), two small rounded bodies situated on the basal aspect of the brain (figs. 439, 445). From the posterior extremity of the body pass backwards the two *posterior pillars* of the fornix. They are widely apart. Curving downwards and forwards, to the upper border of the dentate gyrus, they end in a band adherent to that gyrus. To the band—a direct continuation of the posterior pillar—is given the name of TÆNIA HIPPOCAMPI or FIMBRIA. The fimbria ends in the uncus of the hippocampal gyrus (fig. 453, p. 348). The fornix is a longitudinal band of nerve fibres which join centres situated in the basal ganglia with other areas of nerve cells situated in the hippocampal gyrus.

The SEPTUM LUCIDUM is best studied as now seen in a mesial section of the brain (figs. 445, 453, p. 348). It is a thin triangular layer of grey matter attached by its upper border to the under surface of the corpus callosum; by its lower to the anterior pillar of the fornix; its rounded anterior extremity adheres to the rostrum of the corpus callosum. It usually contains a narrow closed space, dividing the septum into right and left halves; to this space the name of *fifth ventricle* has been given.

The **Gyrus Dentatus** or **Fascia Dentata** is a thin serrated band of grey matter hid between the outstanding hippocampal gyrus and the fimbria (fig. 453, p. 348). It ceases in front on the uncus as the band of Giacomini ; it becomes continuous behind the splenium with the vestigial supracallosal gyrus (fig. 453).

HIPPOCAMPAL or DENTATE FISSURE.—This fissure separates the gyrus dentatus from the uncinate (hippocampal) gyrus (fig. 453, p. 348). It is best understood by making afterwards a section of the hippocampal gyrus.

Termination of the Crura Cerebri.—The crura cerebri or peduncles of the brain were seen on the basal aspect, closely united, passing from the pons to end above, one in each cerebral hemisphere. A section of the peduncle is seen on the mesial aspect of the cerebrum at its point of entrance (fig. 453, p. 348). In fig. 445 it is seen to pass into the brain on the lateral aspect of the third ventricle. The peduncle becomes continuous with the lower aspect of the optic thalamus, and part of this great basal ganglion is also seen in such a section as is shown in fig. 453. The cut surfaces of the optic thalamus and peduncle are seen to lie within the circle of the fornix. Nowhere is the fornix attached to them ; a great semicircular fissure, the Choroidal or Transverse fissure, opening into the lateral ventricles of the brain, separates them. The velum interpositum (see fig. 432, p. 303), a vascular layer of pia mater, passes forwards beneath the splenium of the corpus callosum and projects through the choroidal fissure within the lateral ventricles of the brain.

Third Ventricle of the Brain.—It will be observed that the third ventricle communicates behind with the fourth ventricle in the hind brain by a narrow canal, the aqueduct of Sylvius. In front, too, will be seen a narrow opening—the foramen of Monro—between the anterior end of the optic thalamus and the anterior pillar of the fornix. Through the foramina of Monro, the third ventricle communicates with both lateral ventricles of the brain. It will be observed further that a very thin layer of grey matter, in which the optic chiasma is imbedded, forms the anterior wall and floor of the third ventricle.

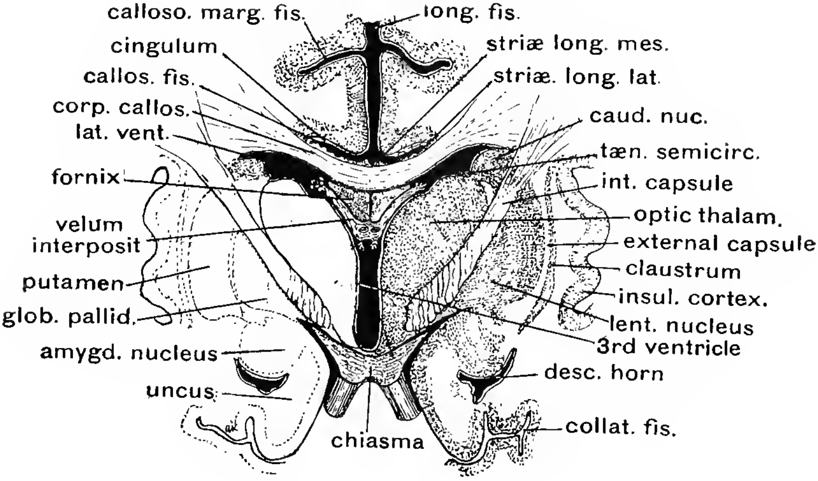
Vertical Coronal Section of the Brain.—There is still one other section of the brain that it is highly profitable for the student to review before proceeding with the deep dissection of the brain. It is a vertical coronal (transverse) section made so as to lay open the lateral and third ventricles (figs. 446, 454, p. 353). Such a section passes through the Island of Reil and appears on the base of the brain just behind the chiasma. The following points should be recognised in it (see fig. 446):

(1) The *corpus callosum.*

(2) The *striæ longitudinales, mesiales et laterales* on its upper surface.

(3) The *fornix* under the middle part of the corpus callosum.

Fig. 446.—A vertical coronal section of the basal ganglia, lateral and third ventricles. (*After Schaefer.*)



(4) The two *lateral ventricles* under the lateral parts of the corpus callosum.

(5) The *velum interpositum* under the fornix.

(6) The narrow *third ventricle* between the two optic thalami and under the velum interpositum.

(7) The *floor* of the third ventricle and optic chiasma.

(8) The *internal capsule*, leaving the cut surface of the crusta of the peduncle, and passing up on the outer side of the optic thalamus to form the corona radiata in the medulla of the cerebrum.

(9) The *lenticular nucleus*, on the outer side of the internal capsule and under the cortical cap of the Island of Reil.

(10) The termination of the *descending horn* of the lateral ventricle outside the uncus. Over the termination is the *amygdaloid nucleus*.

(11) If the student places his fingers within the fissure of Sylvius over the apex of the island of Reil on each side, he has between the fingers of his right and left hand the parts shown in fig. 446. From the apex to the third ventricle from without inwards on each side there are (1) cortex of the island of Reil; (2) a layer of white matter; (3) a thin layer of grey matter—the *claustrum*; (4) the external capsule; (5) the lenticular nucleus, made up of putamen and globus pallidus; (6) the internal capsule; (7) the optic thalamus; (8) the ependyma or lining membrane of the third ventricle.

DEEP DISSECTION OF THE BRAIN

Cortex and Medulla.—The dissector should now proceed to examine the interior of the brain. Up to this point his aim has been to preserve the integrity of the brain, so that the deep parts, which are now to be examined, might be kept in their natural relationships. With a special brain knife the upper convexity of the hemispheres should be shaved off by a horizontal incision half an inch above the level of the corpus callosum.

A thin rind or *cortex* of grey matter, about 3 mm. ($\frac{1}{8}$ inch) thick, in which the nerve cells are placed, surrounds a great white oval *medullary* centre. The medulla is a packed mass of nerve fibres so tangled in their arrangement that nothing can be made out as to their direction with the naked eye. But the student should remember that many of the fibres which make up the medullary mass are streaming from the motor convolutions downwards to the peduncles of the brain and the spinal cord beyond (the *pyramidal fibres*); others are cut as they pass upwards to end in the same convolutions, keeping the cortex in communication with the body (*sensory fibres*); others are passing through the corpus callosum to the other hemisphere (*commissural fibres*), while many short fibres pass from one area of the cortex to another on the same side (*association fibres*). When he remembers the extremely minute size of these fibres, he will have some conception of the millions contained within the medulla of a single hemisphere.

The dissector should now examine certain small tracts of fibres in the neighbourhood of the corpus callosum.

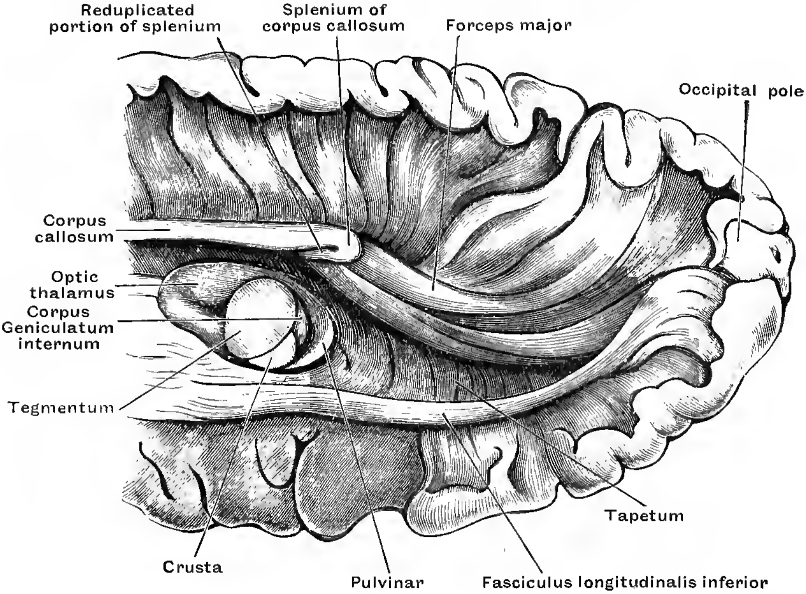
(1) The STRIÆ LONGITUDINALES (see fig. 446) are four minute tracts of fibres which pass backwards on the upper aspect of the corpus callosum. Two of them, the *mesial striæ*, pass backwards close together, one on each side of the median callosal *groove* or *raphe*. They commence in the olfactory lobe and, passing upwards as the peduncles of the corpus callosum on the subcallosal gyrus, they reach the rostrum of the corpus callosum. They pass backwards and disappear round the splenium to end in the fascia dentata (fig. 453, p. 348). The lateral striæ, on the other hand, are vestigial remains of the *supracallosal gyri*, and are hid on the corpus callosum by the overhanging edge of the callosal gyrus. They end behind in the fascia dentata, of which gyrus they are really part (see fig. 453, p. 348).

(2) The CINGULUM is a bundle of fibres which lies hid with the lateral striæ, over the lateral part of the corpus callosum and under the overhanging callosal gyrus (fig. 446). To see it the edge of the callosal gyrus must be raised. The layer of white fibres which compose the cingulum is seen adherent to the callosal gyrus passing in a longitudinal direction. The cingula are commissural or *association* tracts of fibres that unite various areas of the callosal and hippocampal or uncinate gyri (the limbic lobe). They commence in the anterior perforated space, and are found running along the callosal and hippocampal fissures.

Corpus Callosum.—Vertical sections of this great interhemispheric commissure have already been examined; the dissector should now slice off the cortex down to the level of the upper surface of the corpus callosum. The fibres which compose the corpus callosum radiate out in the medulla of each hemisphere (fig. 447); many of the fibres from the cortex of the opposite side pass downwards in the medulla towards the basal ganglia, but their termination is not yet known with a full degree of certainty. The fibres of the genu radiate forwards to the frontal cortex—these fibres form the *forceps minor*; the fibres of the splenium spread outwards and backwards to the occipital lobe—they form the *forceps major*; the lower fibres of the body spread out over the roof and outer wall of the descending and posterior horns. To these fibres the name of *tapetum* is given (fig. 447). The rostral fibres have already been seen on section (fig. 432, p. 303).

Parts beneath the Corpus Callosum.—The corpus callosum has to be removed with the greatest care if the structures which lie beneath it are to be left uninjured. It forms the roof of the lateral ventricles (fig. 446). The body of the fornix and the septum lucidum are adherent to its under surface along the middle line (see fig. 446); these structures separate the two lateral ventricles. The part of the corpus callosum which appeared in the longitudinal fissure should be left *in situ*, while the parts covering the lateral ventricles should be separated from it by longitudinal incisions, raised outwards and dissected away. The lateral ventricles will then be exposed (fig. 448).

FIG. 447.—A DISSECTION OF THE WHITE MATTER OF THE POSTERIOR PART OF THE RIGHT CEREBRAL HEMISPHERE. (VIEWED FROM THE INNER SIDE.) (*Schwalbe.*)

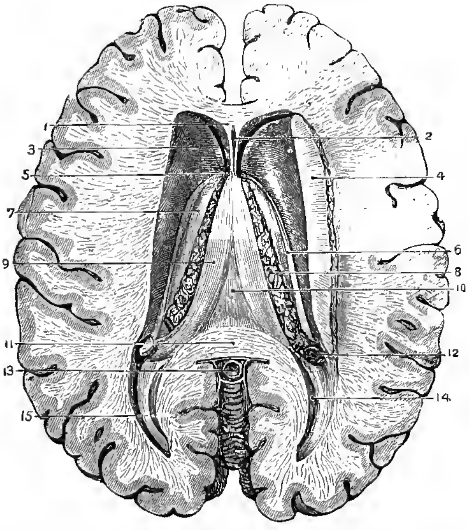

Reduplicated portion of splenium
Splenium of corpus callosum
Forceps major
Occipital pole
Corpus callosum
Optic thalamus
Corpus Geniculatum internum
Tegmentum
Tapetum
Crusta
Pulvinar
Fasciculus longitudinalis inferior

Divisions of the Lateral Ventricle.—The lateral ventricle contains cerebro-spinal fluid; it represents the cavity of the cerebral vesicle out of which the cerebrum was formed. The ventricle is lined by a delicate dark-coloured membrane—the *Ependyma*. The ependyma is covered by a layer of columnar epithelium. Each lateral ventricle is subdivided into four parts: the central chamber or *body*; the *anterior horn* reaching forwards by the side of the septum lucidum (fig. 448); the *posterior horn* projecting backwards within the occipital lobe; the *descending horn*, a recess which passes within the temporal lobe, at the junction of the posterior horn and the body.

Structures forming the Floor of the Body and Anterior Horn of the Lateral Ventricle:

(*a*) The *Caudate Nucleus* is a large comma-shaped mass of grey matter, forming part of the great basal ganglion known as the CORPUS STRIATUM. The rounded head of the nucleus projects on the floor of the anterior horn, while the tail passes backwards on the floor of the body of the ventricle and disappears from view in the roof of the descending horn (fig. 448, 3). If this nucleus is removed on one side by the handle of the scalpel, the fibres of the internal capsule—motor and sensory fibres passing from the crura cerebri to the cortex—are exposed.

FIG. 448.—LATERAL VENTRICLES OF THE BRAIN. (*From Hirschfeld and Leveillé.*)



1. Septum lucidum. 2. Fifth ventricle. 3. Corpus striatum. 4. Corpus callosum, reflected. 5. Foramen of Monro. 6. Tænia semicircularis. 7. Thalamus (opticus). 8. Choroid plexus. 9. Body of fornix. 10. Lyra. 11. Posterior extremity of corpus callosum. 12. Commencement of descending cornu. 13. Vena Galeni. 14. Hippocampus minor. 15. Posterior cornu of lateral ventricle.

(*b*) The *Tænia Semicircularis* (fig. 449) is a small fasciculus of fibres which passes along the inner border of the caudate nucleus. It lies in a groove between the caudate nucleus and optic thalamus. The fibres spring from the anterior pillar of the fornix and disappear on the roof of the descending horn, ending in the amygdaloid nucleus.

(*c*) The intra-ventricular part of the upper surface of the *Optic Thalamus*, marked off from the rest of this surface by the *sulcus choroideus* (fig. 449).

(*d*) The *Choroid Plexus* (fig. 448) or villous fringe of the velum interpositum. The plexus lies on the sulcus choroideus. In the *villi* of the plexus the choroidal arteries terminate and the choroidal veins commence. A vein is seen to leave the corpus striatum and join the choroidal vein in the velum interpositum; the vein of Galen is thus formed (fig. 450). The choroidal villi have to do with the secretion or absorption, or perhaps with both, of the intra-ventricular cerebro-spinal fluid.

(*e*) The free edge of the body of the *Fornix* (fig. 448, 9).

Structures in the Mesial or Septal Wall of the Lateral Ventricles:

(*a*) The *Septum Lucidum* (fig. 442) separates the anterior horn and anterior part of the body of one lateral ventricle from the other. It is only in front that the mesial wall is of any depth (see fig. 449).

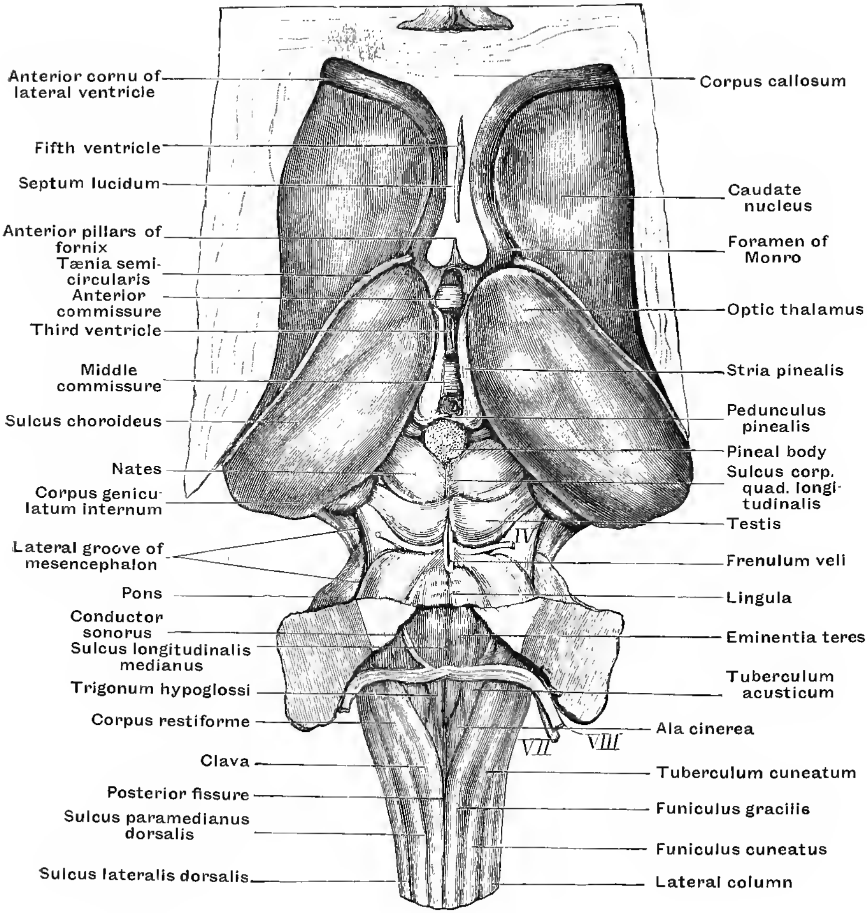
(*b*) Behind, the *body of the fornix* forms the mesial wall, but it is so shallow that the roof, formed by the corpus callosum, almost rests on the optic thalamus (fig. 446).

(*c*) *Foramen of Monro* (fig. 432, p. 303). Between the choroid plexus on the apex of the velum interpositum and the anterior pillar of the fornix, on a level with the ventricular floor, each lateral ventricle communicates with the third ventricle through the foramen of Monro. The two foramina have a common opening into the third ventricle. Their size varies, and probably depends to some extent on the degree of care which has been taken in retaining the natural relationships of the velum interpositum during the removal of the brain.

There is no *outer wall* to the lateral ventricle; the floor rises to meet the roof on the outer side (fig. 446).

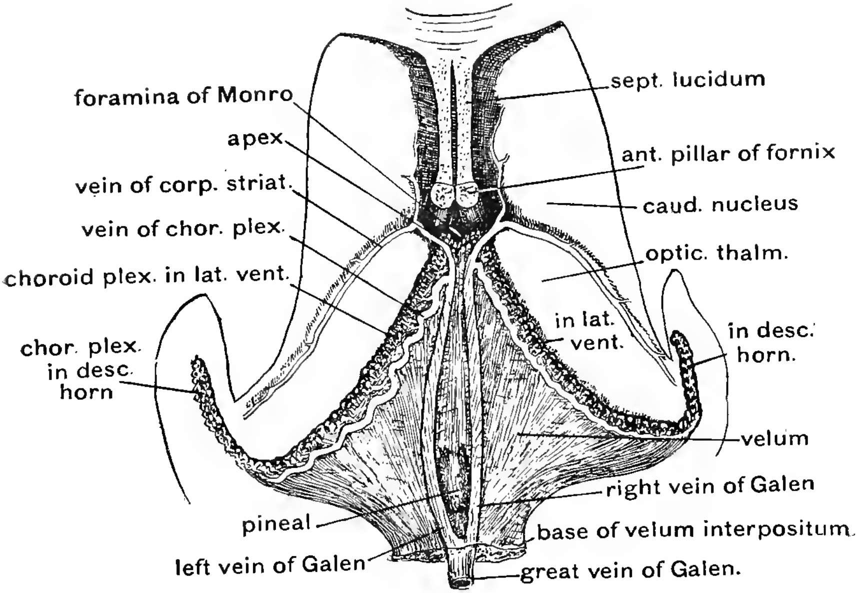
The Posterior Horn of the lateral ventricle is contained in the occipital lobe (fig. 448); the tapetum of the corpus callosum forms its outer wall and roof. The splenial fibres (forceps major) of the corpus callosum give rise to an elevation on the inner wall, the *bulb of the cornu*. Below the bulb, the inner wall is indented by the calcarine fissure; the eminence so caused is named the *Hippocampus minor* or *Calcar avis* (fig. 451). The apex of the horn is directed inwards. The posterior fibres of the internal capsule (optic radiations) pass backwards round its outer wall and floor to end in the cortex of the calcarine fissure. The *fasciculus longitudinalis inferior* also passes backwards in its floor; it is a bundle of association fibres uniting the occipital and temporal lobes (fig. 447).

FIG. 449.—METENCEPHALON, MESENCEPHALON, AND THALAMENCEPHALON, FROM THE DORSAL SURFACE. (*After Obersteiner.*)



Velum Interpositum. DISSECTION.—It is more convenient to examine this structure before undertaking the dissection necessary to expose the descending horn of the lateral ventricle. The velum is seen to pass under the splenium. The splenium is raised upwards and forwards, after being divided on each side at the forceps major. The posterior pillars of the fornix are then seen to pass downwards from the under surface of the splenium to disappear in the descending horn. When the posterior pillars are cut through, the corpus callosum can be raised forwards with the body of the fornix attached to its under surface. The anterior pillars of the fornix should be divided above the foramina of Monro; the septum lucidum is divided forwards to the genu of the corpus callosum. The part of the corpus callosum thus removed has the body of the fornix, parts of the anterior and posterior pillars, and part of the septum lucidum attached to its under surface. The upper surface of the velum interpositum is now exposed (fig. 450). It is an inflection of the pia mater within the ventricles of the brain, through the choroidal or transverse fissure; in the velum vessels enter and leave the ventricles of the brain. A reference to fig. 432, p. 303, and fig. 446, p. 336, may assist in forming an accurate conception of the position and relationships of this important structure.

FIG. 450.—THE VELUM INTERPOSITUM, FROM ABOVE. (*Semi-diagrammatic.*)



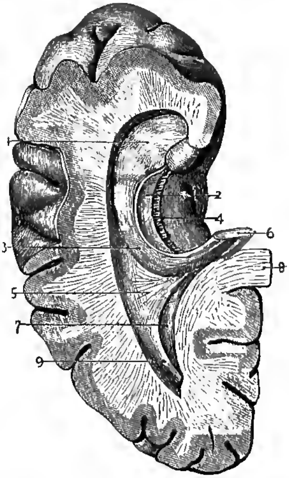
It is *shaped* like an arrow-head (fig. 450); the point of the arrow is broad and projects into the foramina of Monro; its lateral barbs are long and pointed, and project within the descending horns. The base of the arrow lies beneath the splenium, and is there continuous with the pia mater; its free lateral edges project within the ventricles and receive a covering of ependyma (fig. 446). They are fringed by choroidal villi; whether these secrete or absorb the cerebro-spinal fluid, or both, is not definitely settled. The anterior and posterior choroidal arteries, from the internal carotid and posterior cerebral respectively, ramify in the velum and choroidal villi and plexus. The *choroidal vein* commences in the choroid plexus; the *vein of the corpus striatum* passes on to the velum at the foramen of Monro (fig. 450) and joins the choroid vein to form the *Vein of Galen.* The right and left veins of Galen pass backwards and unite to form the *Great Vein of Galen,* a short trunk which ends in the straight sinus (fig. 432). Pressure applied to the veins of Galen may lead to dropsy of the ventricles of the brain.

The **Fissura Choroidea** or **Great Transverse Fissure** is filled by the velum interpositum; when the velum is withdrawn the fissure appears on the mesial surface of each hemisphere as a semicircular slot opening into the body and descending horns of the lateral ventricle (fig. 453, p. 348). The fissure is bounded by the optic thalamus on its shorter or concave side, and by the fornix on its convex or longer side (fig. 453). While the apical and lateral fringes of the velum interpositum project within the lateral ventricle and descending horn, the body of the velum rests between the splenium and body of the fornix above, and the optic thalami and third ventricle below (fig. 446, p. 336). To this interval containing the body of the velum it would be well to restrict the term '*Transverse Fissure,*' and apply the term *choroidal* strictly to the fissure which allows the edges of the velum to pass within the lateral ventricles (see fig. 453, p. 348, and fig. 446, p. 336).

The **Body of the Fornix** should be examined on the under surface of the mesial part of the corpus callosum. It rests on the velum interpositum (see fig. 446). Anteriorly the two pillars come closely in contact (fig. 453). As they pass backwards, forming the body, they diverge widely and become flattened out, the lateral margins projecting in the floor of the lateral ventricles. Between the diverging pillars are transverse and oblique bands of grey matter and fibres. To this striated part, adherent to the under surface of the splenium, the name of *lyra* has been given.

Parts covered by the Velum Interpositum (see fig. 446).—On each side the velum rests on the upper surface of the optic thalamus; between the optic thalami its lower surface forms the roof of the third ventricle and is there covered by the ependyma lining that chamber (fig. 446). A mass of villi hangs within the third ventricle from its under surface. As the velum interpositum is removed, care must be taken at the posterior end of the third ventricle, for there the pineal body projects within and is adherent to the velum (fig. 449, p. 342). Removal of the velum also exposes the corpora quadrigemina on the dorsal aspect of the crura cerebri (mesencephalon) (fig. 449).

Fig. 451.—The descending and posterior cornua of the lateral ventricles. (*Hirschfeld and Leveillé.*)

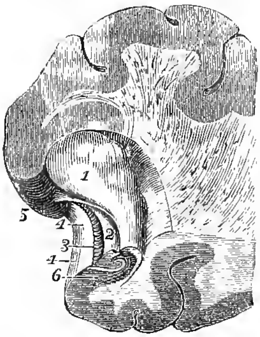


1. Pes hippocampi. 2. Tænia hippocampi. 3. Hippocampus major. 4. Dentate convolution with opening of dentate fissure on its inner side, and the upper surface of the uncinate gyrus internal to the fissure. 5. Eminentia collateralis. 6. Posterior pillar of fornix (cut). 7. Hippocampus minor (the forceps major is seen on the inner side of this in continuity with the splenium). 8. Splenium of corpus callosum (cut). 9. Posterior cornu.

The **Descending Horn of the Lateral Ventricle** can now be freely examined. It lies within the temporal lobe. To examine it conveniently, the temporal and occipital lobes should be removed together (fig. 451). This is not a difficult matter; for the section of the posterior pillars of the fornix, the withdrawal of the velum interpositum, and the removal of the corpus callosum allow the two lobes to be broken away at the Sylvian and choroidal fissures. Tapetal fibres of the corpus callosum form its roof and outer wall. The descending horn is bent under the lower lateral aspect of the optic thalamus (fig. 446).

Parts to be recognised in the Descending Horn (figs. 451 and 452).—1. The Hippocampus Major (fig. 451, 1) forms a sharply marked elevation along its floor. Near the lower extremity of the horn, just external to the uncus, the hippocampus becomes enlarged and ends in an indented extremity, the *pes hippocampi*. If the dissector will separate the *dentate gyrus* (fascia dentata) from the *hippocampal* or uncinate (fig. 453) and insert the handle of his knife in the hippocampal fissure which separates these two gyri, he will find that it may be passed within the hippocampal elevation. The hippocampus major is an inflection in the floor of the descending horn, caused by the hippocampal fissure. This is best seen in such a section as is shown in fig. 451. Thus it will be seen that a considerable area of cortex is buried on the walls of the hippocampal fissure.

FIG. 452.—A SECTION THROUGH THE STRUCTURES IN THE FLOOR OF THE DESCENDING HORN. (*Hirschfeld and Leveillé.*)



1. Pes hippocampi. 2. Fimbria. 3. Fascia dentata. 4, 4. Hippocampal gyrus. 5. Uncinate gyrus. 6. Section through the hippocampus.

2. The EMINENTIA COLLATERALIS is a less distinctly marked triangular elevation on the floor of the upper part of the descending horn (fig. 451, 5). It will be found to be caused by the collateral fissure.

3. The POSTERIOR PILLAR OF THE FORNIX and its forward continuation, the FIMBRIA, pass forwards adhering to the inner margin of the hippocampus major. The Fornix as a whole has been already seen (fig. 453). The Fimbria ends anteriorly in the Uncus.

4. The ALVEUS, a layer of white fibres, arranged longitudinally on the hippocampus major. The fimbria represents the thickened lateral margin of the alveus.

5. The CHOROID PLEXUS almost fills the descending horn. The plexus is attached to the lateral barb of the velum interpositum which lies between the fimbria and the optic thalamus and closes the choroidal fissure (figs. 450, 453). The fissure is an artificial hiatus in the descending horn, caused by the withdrawal of the velum interpositum and choroid plexus.

6. The AMYGDALOID NUCLEUS is a mass of grey matter within the uncus, overhanging and bulging into the termination of the descending horn. It lies below the lenticular nucleus (fig. 446).

7. The TAIL OF THE CAUDATE NUCLEUS descends on the

roof of the horn and ends near the amygdaloid nucleus. The *Tænia semicircularis* also accompanies the tail of the caudate nucleus and ends in the amygdaloid nucleus. The tænia was already seen in the floor of the lateral ventricle in the groove between the caudate nucleus and optic thalamus (fig. 449).

Rhinencephalon.—After enumerating the six great lobes into which the *cortex* of the brain is divided on p. 327 it was mentioned that there still remained certain gyri, vestigial in nature for the greater part, which did not fall into either of the six great lobes. On the other hand, there can be little doubt that they constitute by themselves not an unnatural lobe of the cortex, to which the name *rhinencephalon* is given. Most of the areas of cortex which belong to this lobe have been already seen; they need only again be noted and grouped together (see fig. 453). They are:

(1) The *olfactory bulb* and *tract*.

(2) The *mesial* and *lateral* olfactory *roots* with the *trigonum olfactorium* between them; 1 and 2 are developed as the olfactory lobe from a point of the embryonic cerebral vesicle represented by the extremity of the anterior horn of the lateral ventricle.

(3) The *anterior perforated space*, separated from the trigone by a transverse fissure; also the grey matter in the depth of the vallecula Sylvii. The rhinencephalon or rhinencephalic lobe is 'racquet-shaped,' and the three parts just described correspond to the handle.

(4) The *subcallosal gyrus* under the rostrum (fig. 453), the *supra-callosal gyrus*, including the mesial and lateral striæ longitudinales and all the grey matter on the upper surface of the corpus callosum, belong to this lobe. The corpus callosum was developed in the upper part of the lobe.

(5) The *septum lucidum* (grey cortical matter) and the *grey matter* of the *fornix*, between the body of the fornix and the corpus callosum, are also parts of this lobe. Parts 4 and 5 represent the upper limb of the racquet-shaped lobe (fig. 453).

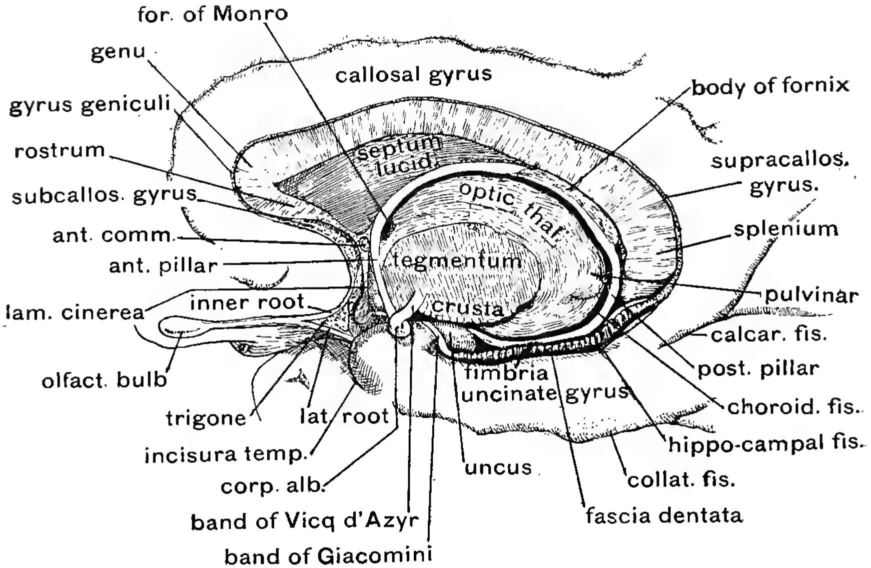
(6) The *fascia dentata* (dentate gyrus) runs backwards and becomes continuous with the supracallosal vestigial gyrus under the splenium (fig. 453). The dentate gyrus represents the inner margin of the cortex.

(7) The cortex buried in the hippocampal fissure, with the posterior part of the uncus and two other pieces of cortex that

may come to the surface under the splenium (fig. 453). Parts 6 and 7 constitute the lower limb of the racquet-shaped lobe.

Now, as may be seen from fig. 453, the posterior part of the loop of the racquet bounds and fringes the choroidal fissure. It is to be remembered that the *fornix* and *fimbria* are developed, as can be readily seen from fig. 453, in the margin of the rhinencephalic cortex which bounds the choroidal fissure. Although the anterior pillars have ultimately their most close connections with the optic thalamus, yet fibres do leave the anterior pillars and pass to the gyrus subcallosus. The fornix then, for the great part, is the commissure of the rhinencephalon. Lastly it will be seen that the choroidal fissure is situated between what is really the inner margin of the rhinencephalon (occupied by the fornix) and the optic thalamus. In this description of the rhinencephalon the teaching of Dr. Elliot Smith has been closely followed.

FIG. 453.—THE VESTIGIAL GYRI OF THE RHINENCEPHALON, THE CHOROIDAL FISSURE, FORNIX, AND CORPUS CALLOSUM.



The **Third Ventricle** is now seen from above as a narrow space between the two optic thalami (fig. 446, p. 336). The adjacent surfaces of the optic thalami are often joined or fused together in their central parts by a wide band—the middle or *grey commissure.* The ROOF of the ventricle is formed by the velum interpositum; over the velum and in close contact with it lie the body of the fornix and corpus callosum (fig. 446). It presents for examination: (1) floor, (2) roof, (3) lateral walls, (4) anterior extremity, (5) posterior extremity.

The **Floor of the Third Ventricle** is a narrow, thin lamina of grey matter, which should now be examined on its inner as well as on its outer aspect, already seen on the base of the brain (Plate LIV, p. 314). The following parts appear in the floor, from before backwards (see fig. 439, p. 317, and fig. 458, p. 363):

(*a*) The *optic chiasma.*—There is an intra-ventricular recess both in front of it and behind it. That in front is known as the optic recess.

(*b*) The *tuber cinereum,* a thin plate of grey matter seen on the basal aspect as an elevation behind the chiasma and optic tracts and between the peduncles of the brain.

(*c*) The *infundibulum* or stalk of the pituitary body. It projects downwards from the tuber cinereum (fig. 319, p. 125).

(*d*) The *corpora mammillaria* or *albicantia,* two rounded nodules, not visible in the floor from within but seen projecting on the inter-peduncular space on the basal aspect of the brain.

(*e*) The *posterior perforated space* in the angle between the crura cerebri or peduncles of the brain. Through it the postero-mesial branches of the posterior cerebral arteries reach the third ventricle and grey matter surrounding it.

It will be thus seen that the diamond-shaped INTER-PEDUNCULAR SPACE (Plate LIV) bounded by the peduncles, optic tracts, and chiasma, seen on the basal aspect of the brain, forms the floor of the third ventricle.

At the ANTERIOR EXTREMITY of the ventricle the following points should be examined (see fig. 432, p. 303, and fig. 319, p. 125).

(*a*) The *Lamina Cinerea,* a thin plate of grey matter stretching from the rostrum of the corpus callosum above to the optic chiasma below (fig. 453). It forms the anterior wall of the ventricle.

(*b*) The *Anterior Pillars* of the fornix, which diverge somewhat as they bend downwards and backwards, slightly buried in the lateral wall of the ventricle, to end in the corpora mammillaria (fig. 449).

(*c*) The *Anterior Commissure*, a thick rounded strand of fibres which connects one temporal lobe with the other. It is seen within the anterior extremity of the ventricle, passing across in front of the anterior pillars of the fornix. Its position is best studied in such a section as is shown in fig. 453, p. 348, or fig. 432, p. 303.

(*d*) The *Foramina of Monro*, passing upwards on each side between the anterior pillar of the fornix and the prominence of the anterior extremity of the optic thalamus (fig. 449).

At the POSTERIOR EXTREMITY of the third ventricle the student should examine:

(*a*) The *Opening* of the *Aqueduct of Sylvius* (see fig. 432, p. 303).

(*b*) The *Posterior Commissure*, a thin transverse band which projects above the opening of the aqueduct (fig. 432, p. 303). It is part of the dorsal commissural fibres found in the quadrigeminal plate of the mesencephalon.

(*c*) The *Pineal Body* is about the size of a grain of wheat or a cherry-stone (fig. 449). It adheres to the under surface of the velum interpositum, lying between the veins of Galen, and rests in the sulcus between the upper quadrigeminal bodies. Its stalk attaches it to the posterior extremity of the third ventricle above the opening of the aqueduct. A strand of fibres (stria pinealis) emerges from the stalk on each side and passes forwards on the optic thalamus along the upper margin of the lateral wall of the third ventricle. The depression between the optic thalamus and pineal stalk is the *trigonum habenulæ*. The ganglion of the habenula or stalk of the pineal body lies in its floor. The pineal *recess* projects with the stalk of the body (fig. 432).

The ROOF of the third ventricle is formed by the velum interpositum. The choroid plexus of the ventricle—the structure concerned in the secretion or absorption of the cerebro-spinal fluid—hangs within the ventricle from the roof (fig. 446).

The third ventricle is lined by *ependyma*, a thin layer of grey matter and neuroglia covered with columnar ciliated epithelium. The ventricle contains cerebro-spinal fluid, which is in communication with the fluid of the lateral ventricles through the foramina of Monro and with that of the fourth ventricle through the aqueduct of Sylvius (fig. 432).

Optic Tracts (see fig. 439, p. 317).—From the third ventricle in the embryo arose the optic vesicles, out of which the retina, optic nerves and tracts were formed. Hence the termination of the optic tracts in the grey matter which surrounds the third ventricle. The *optic recess*, in the floor of the ventricle in front of the chiasma, marks the point in the ventricle at which the vesicles arose (fig. 432, p. 303).

Along the optic tracts, stimuli started in the retina by rays of light pass to certain masses of nerve cells in the neighbourhood of the posterior extremity of the third ventricle. In their passage outwards, along the anterior border of the interpeduncular space and round the crura cerebri (fig. 439, p. 317) to reach the posterior extremity of the optic thalamus, the optic tracts are hid by the hippocampal or uncinate gyri of the limbic lobes (fig. 455); with the removal of the temporal lobe this gyrus also was removed and the optic tracts exposed.

TERMINATION OF THE OPTIC TRACT.—As the optic tract (fig. 456, p. 358) reaches the posterior inferior surface of the optic thalamus, it divides into an anterior or lateral and a posterior or mesial division. The *anterior* or *lateral division* terminates (1) in the projecting posterior extremity of the optic thalamus —the *pulvinar*; (2) the *external geniculate body*, a small mass of nerve cells situated on the optic thalamus below and external to the pulvinar (fig. 456); (3) the upper *corpus quadrigeminum*. The fibres passing to this body form the superior brachium (fig. 460).

The *posterior* or *mesial division* of the tract, much smaller than the anterior, ends in the *internal geniculate body*, a small, rounded, well demarcated elevation behind and below the pulvinar and external to the superior corpus quadrigeminum. It is probable that the fibres of the posterior division are not connected with the optic nerves, but are really part of Gudden's commissure—a bundle of fibres that runs in the optic tracts, crosses at the chiasma, and joins the two internal geniculate bodies together. It will thus be seen that the three parts of the basal ganglia connected with the sense of sight are (1) the pulvinar; (2) the external geniculate body; (3) the superior corpus quadrigeminum. The three centres just named are connected by the *optic radiations* with the cortex of the occipital lobe, in the neighbourhood of the calcarine fissure (fig. 449).

THE BASAL GANGLIA AND INTERNAL CAPSULE

The **Internal Capsule** is best exposed by a horizontal section which, beginning on the lateral aspect of the brain, shaves off the upper third of the island of Reil and the crowns of the caudate nucleus and optic thalamus. The internal capsule is then exposed as is shown in the left side of fig. 455.

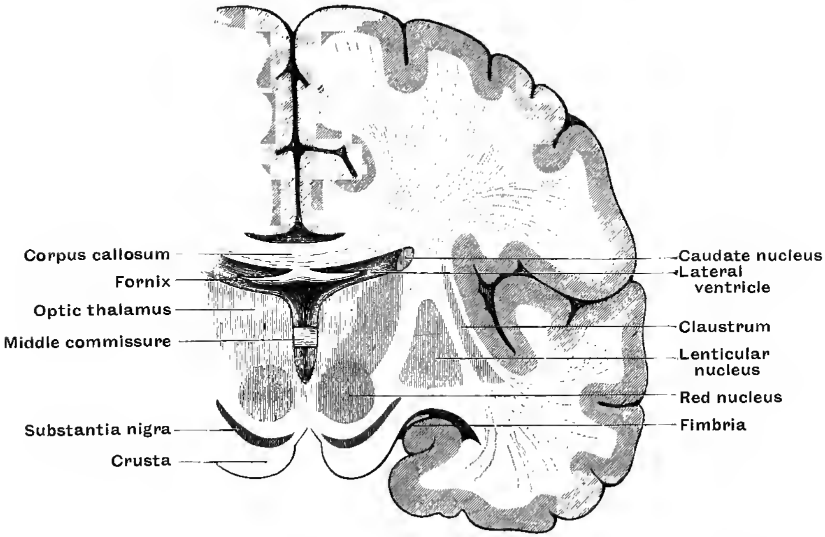
The beginner has a difficulty in fully grasping what the internal capsule is. The enormous number of nerve fibres which connect directly or indirectly the nerve cells in the cortex of the brain with other nerve cells situated in the spinal cord, medulla, cerebellum, pons and mesencephalon (crura cerebri) are massed in a solid sheet as they pass between the great ganglia at the base of the brain (fig. 454). The internal capsule is the term applied to the sheet of fibres as they pass between the basal ganglia. Above the basal ganglia, in the medulla of the brain, they spread out to form the *corona radiata* ; below the ganglia they form the *crusta* of the crura cerebri.

As now seen in horizontal section, the *anterior limb* of the internal capsule is bent on the *posterior limb*, the angle or *genu* having its concavity directed outwards (fig. 455). The lenticular nucleus, a great ganglionic mass of grey matter beneath the island of Reil, fills the concavity of the internal capsule (fig. 455). The caudate nucleus covers the inner aspect of the anterior limb ; the optic thalamus covers the inner aspect of the genu and posterior limb.

The conception of the internal capsule may be amplified by the examination of a coronal vertical section of the brain, such as is shown in figs. 446 and 454. The internal capsule is seen in this view to ascend to the medulla of the brain, between the optic thalamus and caudate nucleus on its inner and the lenticular nucleus on its outer side.

The fibres which pass between the lower parts of the central nervous system and the sensori-motor areas of the cortex—fibres which convey motor and sensory impulses—are situated in the genu and in the adjoining third of the anterior limb and the two-thirds of the posterior limb of the internal capsule ; the fibres for the face and tongue lie most anteriorly, those for the leg, foot, and perineum most posteriorly; those for intermediate parts of the body occupying intermediate positions. So closely are the fibres grouped together here that a small hæmorrhage from one of the antero-lateral perforating arteries, as it passes from the lenticular to the caudate nucleus, gives rise to a widely spread paralysis. In the posterior third of the posterior limb the fibres which form the optic radiation pass upwards. They come, in part at least, from the terminal ganglia of the optic tracts and pass to the occipital lobes. The fibres in the anterior two-thirds of the anterior limb of the internal capsule pass to the cortex of the frontal lobe.

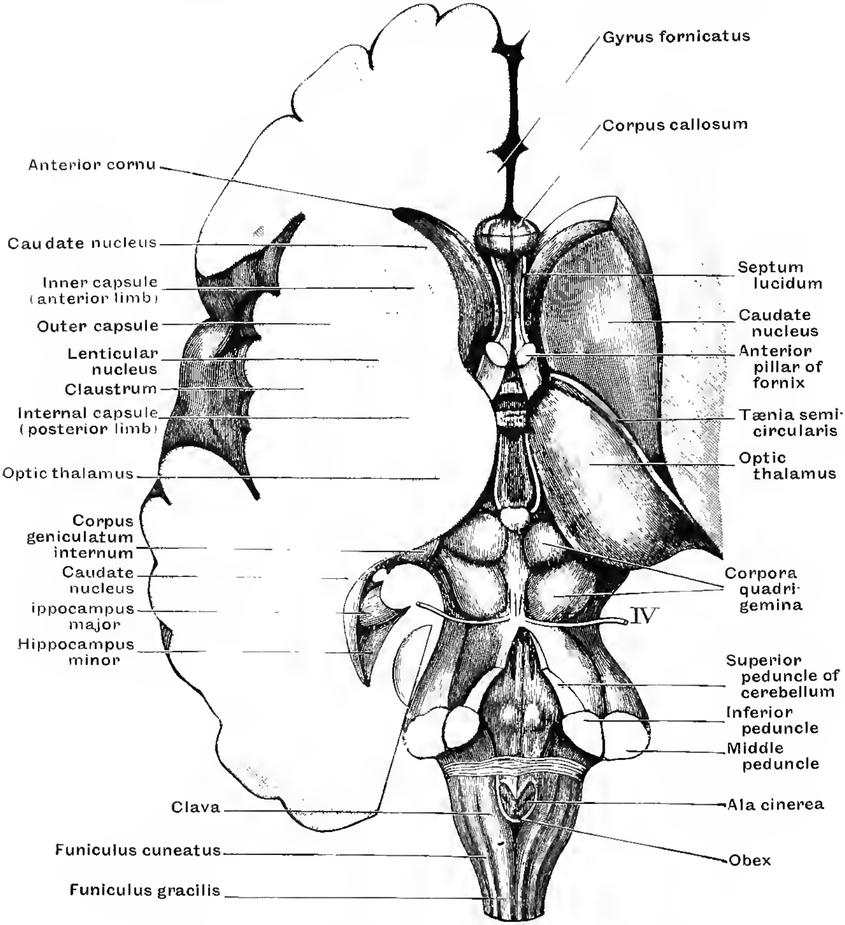
FIG. 454.—CORONAL SECTION OF THE BRAIN THROUGH THE THIRD VENTRICLE AND BASAL GANGLIA BEHIND THE MIDDLE COMMISSURE. (*Gegenbaur.*)



Corpus Striatum.—The internal capsule divides this great basal ganglion into two nuclei: the CAUDATE NUCLEUS, seen on the floor of the lateral ventricle, covering the inner or ventricular aspect of the internal capsule (fig. 454), and the LENTICULAR NUCLEUS, which fills the concavity of the internal capsule by its deep surface (fig. 455). In front of and below the internal capsule, the two nuclei forming the corpus striatum are fused and come to the surface at the anterior perforated space.

It is interesting to note that the corpus striatum comes to the surface at the anterior perforated space, and there receives the antero-lateral perforating or medullary arteries, but it is also continuous with the amygdaloid nucleus and, through it, with the grey matter of the uncus.

FIG. 455.—HORIZONTAL SECTION OF THE CEREBRUM. (*After Landois and Stirling.*)



The **Lenticular Nucleus** is not completely separated from the caudate nucleus; bands of grey matter cross the anterior part of the internal capsule and connect the two nuclei. As seen in the present section the nucleus is lenticular in shape. The outer darker part of the nucleus is distinguished as the *putamen*, the inner paler part as the *globus pallidus* (fig. 446, p. 336). The genu and posterior limb of the internal capsule separate the lenticular nucleus from the optic thalamus.

To fill in the picture of its relationships, the student should consult a vertical section, such as is shown in fig. 446, p. 336. The lenticular nucleus is then seen to be triangular in section. Its base rests in front on the anterior perforated space; there the antero-lateral central arteries enter it; behind it rests on the descending horn of the lateral ventricle and is continuous with the amygdaloid nucleus in the uncus. Externally the island of Reil forms a cap to it.

Claustrum and External Capsule.—Beneath the cortex of the island of Reil there is a thin layer of grey matter. To this layer, probably a separated deep stratum of the insular cortex, the name of *claustrum* is given. The external capsule is a thin layer of white matter which separates the lenticular nucleus and claustrum (fig. 454).

Position of the Basal Ganglia and Ventricles.—It is often a matter of importance to be able to locate the position of the ventricles of the brain on the surface of the head. The dissector will observe that the island of Reil caps the ganglionic mass which, in turn, bounds the third ventricle, and that it lies below the level of the floor of the lateral ventricle. If, therefore, he can locate on the head the position of the island of Reil he can also define the position of the ventricles. Now the island of Reil lies in the anterior two-thirds of the fissure of Sylvius, and the superficial markings for this fissure may therefore also be used to indicate the position of the ventricles. The occipital end of the island of Reil marks the common point of junction of the posterior horn, descending horn, and body of the lateral ventricle. This point is indicated on the head by the point of junction of the posterior and middle thirds of the posterior limb of the fissure of Sylvius.

The **Optic Thalamus** has been already partially examined. Perhaps the student may receive some aid in forming a picture of this body in his mind, and its relationships, especially to the internal capsule, by the use of a rather crude simile. Suppose for a minute that the wrists represent the crustæ, the palms of the two hands the right and left internal capsules, and the fingers the coronæ radiatæ. The palms are turned upwards and towards each other, the little fingers point forwards, the thumbs backwards, and the ulnar margins of the wrists diverge to represent the inter-peduncular space. If now he places in each palm an egg, one pole being directed forwards, the other backwards, he will have a fairly accurate conception of the main relations of the optic thalamus to the internal capsule. It would be better to use an oval mass of modeller's clay, flattening its lower and outer surfaces against the palm. The inner surfaces of the masses of clay, directed towards each other, represent the lateral walls of the third ventricle. Further, the position of the corpus striatum may be represented by applying to the back of the hand a wedge-shaped piece, its edge upwards at the knuckles and base downwards at the wrist, to represent the lenticular nucleus. Then, by carrying a comma-shaped piece from that on the back of the hand round the base of the little finger and ulnar border of the hand and across the palm above the mass representing the optic thalamus, a fairly accurate representation of the caudate nucleus will be made. Thus it will be seen that the optic thalamus rests on the inner and upper aspect of the internal capsule. Further, if the tegmentum be supposed to be situated on the flexor aspect of the wrist (upper surface of crusta), it can be seen that if continued forwards into the palm it (the tegmentum) will fuse with the posterior and lower aspects of the optic thalamus; the junctional region is known as the *subthalamic tegmental region.*

Surfaces of the Optic Thalamus.—Its *inner surface* was seen to form the lateral wall of the third ventricle; its *upper surface* is subdivided by the groove for the choroid plexus into two parts; the *antero-lateral* part assists to form the floor of the lateral ventricle (fig. 449, p. 342); the *postero-mesial* part was covered by the velum interpositum and fornix. The attenuated *anterior extremity* ends at the foramen of Monro. Its *posterior extremity* forms the pulvinar, in which a part of the optic tract terminates. On the outer aspect of the pulvinar is situated the external geniculate body. The descending horn passes downwards beneath and outside the optic thalamus (fig. 455).

Its *ventral* or *lower* and *outer* surfaces present the greatest difficulties, especially as regards their relationships to the crura cerebri and internal capsule. When the crura of the brain are examined on their outer and lower aspects they are seen to pass up and disappear on the ventral or lower aspect of the optic thalamus. The dorsal or upper part of the crus, the *tegmentum*, composed mostly of grey matter, terminates directly in the grey matter of the optic thalamus. Indeed the optic thalamus may be rightly regarded as a great terminal expansion of the dorsal grey matter of the crus. The crusta or ventral part of the crus, composed of the great bundles of nerve fibres which pass between the brain and lower nerve centres, is deflected upwards on the lower and outer aspect of the optic thalamus to form the internal capsule (fig. 454). As now seen on horizontal section (fig. 455), the posterior limb of the internal capsule separates the outer side of the optic thalamus from the lenticular nucleus.

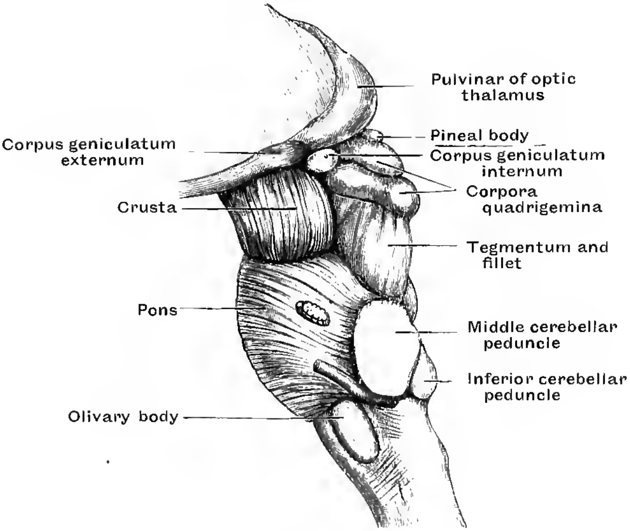
Bundle of Vicq d'Azyr and Corpora Mammillaria.—The two corpora mammillaria appear in the inter-peduncular space. If the optic thalamus of one side be removed with the mammillary body attached, the *bundle of Vicq d'Azyr* can be dissected out, passing from the corpus to the substance of the optic thalamus (fig. 453). The anterior pillar of the fornix begins in the mammillary body from a collection of nerve cells. It commences by a curious twist (fig. 453, p. 348), and passes up in the inner aspect of the optic thalamus to become free in front of the foramen of Monro. It will thus be seen that the fornix is a longitudinal band of fibres which, starting in the optic thalamus through the bundle of Vicq d'Azyr, after describing an almost complete circle round that body, terminates beneath it in the hippocampal gyrus.

MESENCEPHALON

The **Mesencephalon** (fig. 456) is about 18 mm. ($\frac{3}{4}$ inch) long and unites the pons Varolii and cerebellum below with the optic thalamus and internal capsule above; it contains the aqueduct of Sylvius (fig. 458). The dorsal aspect of the mesencephalon is covered by the velum interpositum and splenium of the corpus callosum. It lies in the tentorial passage, between the cerebral and cerebellar compartments of the skull (fig. 316, p. 118). It is made up of two parts—the CRURA CEREBRI (peduncles of the brain) and LAMINA QUADRIGEMINA, in which the corpora quadrigemina are situated. Each crus cerebri is made up of two parts—the *crusta* and *tegmentum*.

When the parts are in their natural position the mesencephalon is only visible on the *basal aspect* of the brain (Plate LIV, p. 314). The *crustæ,* which form the most ventral parts, are seen emerging from the pons and diverging as they pass upwards to disappear in the base of the cerebrum. On the *lateral aspect,* the mesencephalon is hid by the temporal lobe, the hippocampal gyrus of the limbic lobe being in direct contact with it. The optic tracts turn round it to end partly on its dorsal aspect (fig. 456); the fourth pair of nerves passes forwards, one on each side of it (fig. 449). The posterior cerebral and superior cerebellar arteries lie on it in their course backwards. Its *dorsal aspect* is hid by the splenium, velum interpositum, and occipital lobes. The pineal body lies in the mesial groove between the superior corpora quadrigemina.

FIG. 456.—LATERAL VIEW OF MESENCEPHALON, PONS, AND MEDULLA. (*Gegenbaur.*)

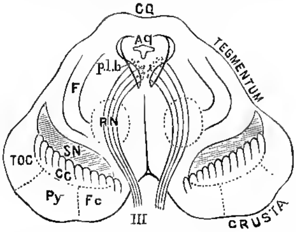

Pulvinar of optic thalamus
Corpus geniculatum externum
Pineal body
Corpus geniculatum internum
Corpora quadrigemina
Crusta
Tegmentum and fillet
Pons
Middle cerebellar peduncle
Inferior cerebellar peduncle
Olivary body

VARIOUS ASPECTS OF THE MESENCEPHALON.—A view of the mesencephalon on its *basal* or *ventral aspect* is given in fig. 439, p. 317; the crustæ are seen to diverge and include between them the interpeduncular space. The lateral aspect of the mesencephalon is shown in fig. 456. The *lateral sulcus* is seen to separate the crusta from the tegmentum. The dorsal aspect is shown in fig. 449. It shows the four corpora quadrigemina.

The superior peduncles of the cerebellum, which are seen to enter the tegmenta, the superior medullary velum and the origin of the fourth pair of nerves do not form part of the mesencephalon, however, but of the hind brain.

Structures seen in a Transverse Section of the Mesencephalon.—The parts entering into the formation of the mesencephalon are best understood by making such a section through it as is shown in fig. 457. The knife should be entered on the dorsal aspect, between the anterior and posterior corpora quadrigemina, and brought out on the ventral aspect, a little in front of the upper border of the pons, at the points of exit of the third pair of cranial nerves.

FIG. 457.—TRANSVERSE SECTION OF THE MESENCEPHALON. (*Wernicke and Gowers.*)



CQ. Corpora quadrigemina. *Aq.* Aqueduct of Sylvius. *p.l.b.* Posterior longitudinal bundle. *F.* Fillet. *R.N.* Red nucleus. *SN.* Substantia nigra. *TOC.* Fibres passing between cerebellum and temporo-sphenoidal convolutions. *Py.* Pyramidal tract. *Fc.* Fibres passing to frontal convolutions from cerebellum. *III.* Origin of the third nerve.

The parts seen in section are:

(*a*) *Aqueduct of Sylvius.*—This part of the central neural canal is T-shaped in section near the fourth ventricle, becoming triangular as the section approaches the third ventricle. The epithelium which lines it is columnar and ciliated. It should also be examined in a longitudinal section such as is shown in fig. 458.

(*b*) *Grey Matter surrounding the Aqueduct.*—In the grey matter along the floor are situated the nuclei of the third and fourth nerves. The fifth nerve also derives part of its origin from it.

(*c*) The *Substantia Nigra* (SN, fig. 457) is a deeply pigmented layer of nerve cells, which separates the *Crusta* below from the *Tegmentum* above (fig. 457). Processes of the pigmented matter dip in between the adjacent bundles of fibres of the crusta.

(*d*) The *Crusta* is not only demarcated from the tegmentum by the substantia nigra as seen in section, but its lateral margin projects beyond the tegmentum. On the lateral aspect of the mesencephalon the crusta and tegmentum are separated by a sulcus; on their mesial aspect, as seen within the interpeduncular space, they are separated by the mesial or oculo-motor sulcus, at which the third nerve emerges. The crusta is composed of nerve fibres; it is in reality a prolongation of the majority of the fibres of the internal capsule; its middle third is occupied by the pyramidal or motor fibres; its outer third contains fibres which pass from nuclei in the pons and medulla to centres in the cerebrum; its inner third contains fibres which, passing through the internal capsule, end in the cortex of the frontal lobe. The crustæ, which separate as they leave the pons, diverge as they pass upwards and bound the interpeduncular space behind (Plate LIV, p. 314).

(*e*) The *Tegmentum* is made up of groups of nerve cells and interwoven nerve fibres. It is seen to be separated from the crusta by the substantia nigra; on its dorsal aspect it is covered by the corpora quadrigemina, which form the roof of the aqueduct of Sylvius. It is continuous above with the optic thalamus; it is connected below with the formatio reticularis of the pons. As seen in transverse section, a median *raphe* separates the tegmentum of one side from that of the other, their mesial surfaces being thus fused together, while their lateral surfaces are free. The roots of the third nerve may be seen piercing it to emerge at the interpeduncular space in the groove between the crusta and tegmentum. The lateral aspect of the tegmentum (fig. 456) is covered by fibres passing towards the inferior corpus quadrigeminum. These fibres belong to the lateral *fillet*.

(*f*) The *Red Nucleus* (fig. 454).—As the roots of the third nerve pass through the tegmentum they pierce the *red nucleus*, which is most clearly marked off from the surrounding substance in fresh brains. The superior peduncle of the cerebellum enters the tegmentum and passes to the red nucleus of the opposite side (fig. 457).

(*g*) The *Posterior Longitudinal Bundle and Fillet.*—There are two longitudinal strands of nerve fibres in the tegmentum of great practical import, but they cannot be clearly distinguished by the naked eye in brains preserved in spirit. One is the *posterior longitudinal bundle*, which passes upwards, one on each side, ventral to the grey matter of the floor of the aqueduct and connects the nuclei of origin of the third, fourth, sixth, and seventh cranial nerves (fig. 457). The other is the *fillet*, a band of fibres which unites the nuclei at the termination of the posterior columns of the spinal cord and others in the medulla with nuclei in and above the mesencephalon (fig. 457). Some of its fibres appear on the outer aspect of the tegmentum above the lateral sulcus, and end in the inferior corpora quadrigemina (lateral fillet), but the greater number (mesial fillet) lie dorsal to the substantia nigra.

(*h*) The *Corpora Quadrigemina*, which appear in section as oval caps of grey matter, coated with white, situated on the tegmenta.

Corpora Quadrigemina.—When the mesencephalon is viewed from behind (fig. 449, p. 342), as can be done by reapplying the cut surfaces, the four corpora quadrigemina, two superior and two inferior, arranged in opposite pairs, are seen to be separated by a mesial and a transverse sulcus. Through the fillets, the inferior corpora are connected with the auditory nuclei in the floor of the fourth ventricle. From both the superior and inferior corpora, a ridge or *brachium* passes outwards and forwards on the dorsal aspect of the tegmentum. The brachia of the superior corpora pass outwards beneath the pulvinar and join the anterior or lateral division of the optic tracts. The brachia of the inferior corpora disappear beneath the internal geniculate bodies. The INTERNAL GENICULATE body is situated on the tegmentum, external to and rather in front of the superior corpus quadrigeminum. From the groove between the inferior corpora quadrigemina commences the *frenulum veli*, a strand of fibres which pass to the superior medullary velum or valve of Vieussens.

DISSECTION OF THE HIND BRAIN

Three parts of the Central Nervous System are included in the hind brain, viz.:

(1) The Pons Varolii.
(2) The Cerebellum.
(3) The Medulla Oblongata.

The central or neural canal is dilated in the hind brain and forms the Fourth Ventricle.

The **Fourth Ventricle** (fig. 458) is continuous below with the central neural canal in the lower part of the medulla and spinal cord; through the aqueduct of Sylvius in the Mesencephalon it is in communication with the third ventricle, which in turn, through the foramina of Monro, is connected with the lateral ventricles. The cerebro-spinal fluid is thus in continuity from the utmost points of the lateral ventricles to the blind end of the central canal in the filum terminale of the spinal cord.

There is only one way of seeing the fourth ventricle satisfactorily. The hind brain must be laid open by a section made in the middle line, dividing the cerebellum, pons, and medulla equally into right and left halves (fig. 458). Before doing so, however, the student should open the anterior fissure of the medulla and examine the crossing of the pyramidal tracts (fig. 465, *d*, p. 373).

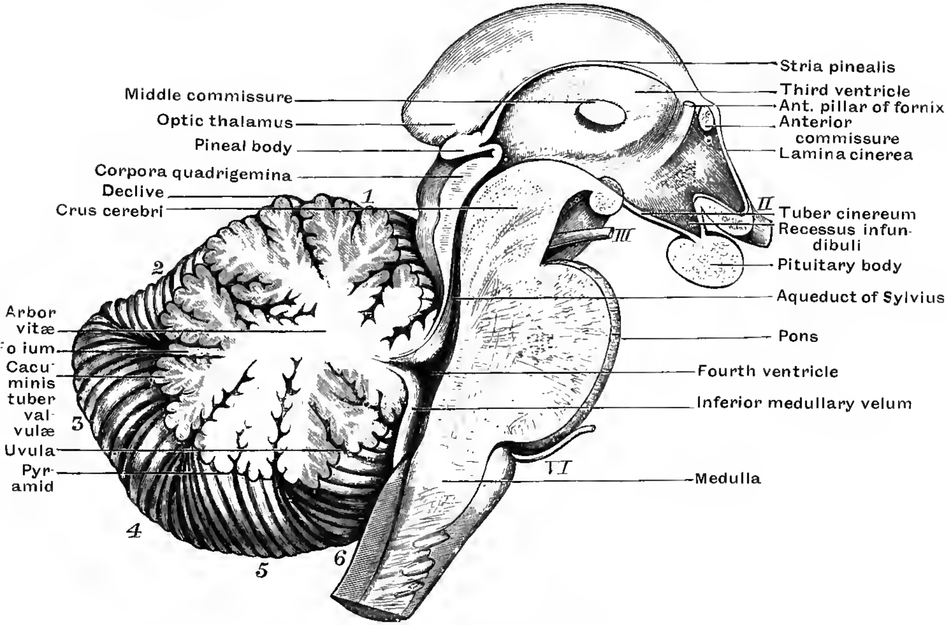
Parts entering into the Formation of the Fourth Ventricle.—As seen in section the fourth ventricle is tent-shaped; the *apex* projects backwards into the cerebellum; the pons and upper half of the medulla form its diamond-shaped *floor*; the *superior medullary velum* (figs. 449, 458) forms the sloping anterior part of the roof; the *inferior medullary velum* constitutes its roof behind. At each side, the floor of the ventricle is prolonged outwards into a *lateral recess*.

(1) The SUPERIOR MEDULLARY VELUM (Valve of Vieussens) is a thin plate of white matter filling the narrow interval between the superior peduncles of the cerebellum (fig. 449, p. 342). It is continuous with the white centre of the cerebellum behind and the roof of the aqueduct of Sylvius in front (fig. 458). The roots of the fourth pair of nerves decussate in it. Its outer aspect is covered by a few laminæ of cortical matter belonging to the cerebellum. To these vestigial folia the name of *lingula* is given. The *frenulum veli* (fig. 449), which commences in the median groove between the inferior corpora quadrigemina, ends on the velum.

(2) INFERIOR MEDULLARY VELUM (fig. 458).—Over the greater part of the posterior sloping roof of the fourth ventricle all nerve elements have disappeared; only the pia mater and the lining epithelium of the central canal are left; this part of the roofing membrane is the *tela choroidea inferior*, the non-neural part of the inferior medullary velum (fig. 466, p. 374). At the attached margins of the velum, however, three laminæ of white nerve matter remain (fig. 466, p. 374). One of these, the *inferior medullary velum proper*, is attached to the nodule and flocculi of the cerebellum, which represent the most posterior parts of the cerebellum of the embryo; it becomes con-

tinuous with the tela choroidea inferior (fig. 466). The other two plates of white nerve matter in the posterior roof of the fourth ventricle are the obex and ligula. The *obex* is situate over the opening of the central canal between the clavæ (fig. 466). From the obex to the lateral angles of the ventricle, the *ligula* marks the point of attachment of the velum (fig. 466). In front of the ligula and behind the auditory nerve and margin of the inferior peduncle of the cerebellum, the lateral angle of the roof is prolonged on each side into a process which is covered by choroidal villi. To this process of the velum the name of *cornucopia* is given (fig. 466); it hangs within the sub-arachnoid space.

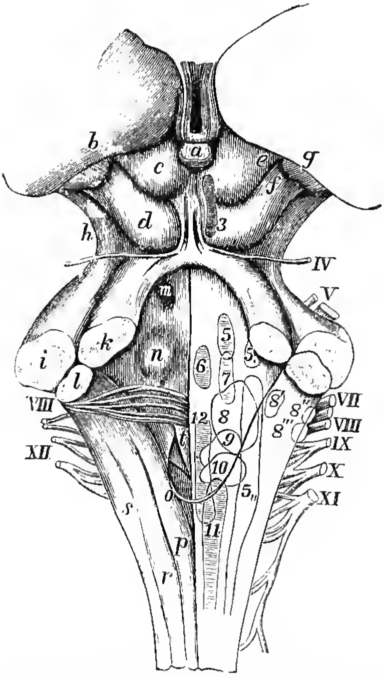
FIG. 458.—THE THIRD VENTRICLE, CRURA CEREBRI, PONS, CEREBELLUM, AND MEDULLA OBLONGATA AS SEEN IN A SAGITTAL MESIAL SECTION. (*Allen Thomson, after Reichert.*)



1. Lobus culminis. 2. Posterior crescentic lobe. 3. Posterior inferior lobe. 4. Slender lobe. 5. Biventral lobe. 6. Amygdala.

The FORAMEN OF MAJENDIE (fig. 466) is an opening in the inferior medullary velum. Thus, while the cerebrospinal fluid within the fourth ventricle is in communication with that in the cerebral ventricles through the Sylvian aqueduct and with that in the central canal of the spinal cord, it is also, through the foramen of Majendie and the openings in the lateral recesses, in continuity with the fluid in the great sub-arachnoid space which surrounds the medulla. Besides the plexus on the cornucopia at its lateral angles, two *choroid plexuses* hang from its under surface within the fourth ventricle; by these the fluid is secreted or absorbed.

Fig. 459.—The floor of the fourth ventricle. (*Erb.*)



a. Pineal body. *b.* Pulvinar of optic thalamus. *c.* Anterior corpus quadrigeminum (nates). *d.* Posterior corpus quadrigeminum (testes). *e.* Anterior brachium. *f.* Posterior brachium. *g.* Internal geniculate body. *h.* Crus cerebri. *i.* Middle peduncle of crus cerebelli. *k.* Superior peduncle (processus e cerebello ad testes). *l.* Inferior peduncle (restiform). *m.* Locus cæruleus. *n.* Eminentia teres. *o.* Obex. *p.* Funiculus gracilis. *r.* Funiculus cuneatus. *s.* Funiculus of Rolando. *t.* Fasciculus teres. The nuclei of the cranial nerves are indicated by arabic figures, the nerve trunks by Roman numerals.

Floor of the Fourth Ventricle (fig. 459).—The upper half of the diamond-shaped floor of the fourth ventricle is formed by the dorsal aspect of the pons; the lower half by the medulla; the floor will be described in connection with these two parts.

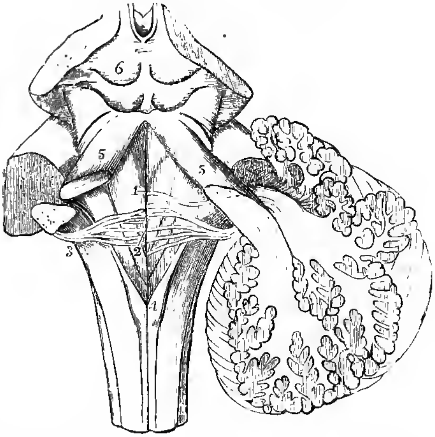
THE CEREBELLUM

The **Cerebellum,** as now seen in section (fig. 458), is made up of a series of transverse lamellæ and minor folia arranged on a central sheet of white matter. A folium in section is found to have a white medulla made up of nerve fibres, and a covering of grey cortex, which, when examined microscopically, is seen to contain the nerve elements shown in fig. 462. A number of folia are grouped together to form a *lamella.* The cortex is covered by pia mater in which the cerebellar arteries ramify and end in fine branches which perforate and supply the substance of the folia.

Peduncles of the Cerebellum.—There are three peduncles on each side; they are made up of bundles of nerve fibres which bring the cerebellum into communication with all the other chief parts of the central nervous system.

The Superior Peduncles (fig. 460) issue from the anterior notch of the cerebellum and, passing forwards, bury themselves in the tegmenta of the mesencephalon. They are the most internal or central of the three peduncles. The *superior medullary velum* stretches between them; they help to form the lateral parts of the roof of the fourth ventricle above. They issue from the dentate nucleus—to be afterwards seen in each lateral lobe of the cerebellum—and pass to the red nucleus in the tegmentum of the opposite side. Through the superior peduncle, also, some of the cerebellar fibres (the antero-lateral ascending) from the spinal cord enter the cerebellum.

Fig. 460.—The peduncles of the cerebellum. (*Hirschfeld and Leveillé.*)



1. Median groove of the fourth ventricle, with the fasciculi teretes, one on each side. 2. The striæ acusticæ and origin of the auditory nerve. 3. The restiform body or inferior peduncle. 4. The posterior pyramid; the figure is placed on the right *clava*. 5. The superior peduncle. 6. The corpora quadrigemina.

The Middle Peduncles of the Cerebellum (fig. 460) are formed by a direct lateral continuation of the fibres of the pons into the cerebellum. They are external in position to both the superior and inferior peduncles (fig. 460). In the cerebellum they spread out in the central sheet of white matter. Through the middle peduncle the cerebellum is connected with masses of nerve cells situated in the pons. It is probable that, through these pontine centres, the fibres found in the mesial or inner third of the crusta form a connection between the cerebellum and frontal lobes of the brain.

The Inferior Peduncles (fig. 460) are continuations of the restiform bodies, which help to bound the floor of the fourth ventricle laterally. They pass upwards internal to the middle peduncle and spread out in the central white sheet of the cerebellum. Through the inferior peduncle the cerebellum is connected with the following nerve centres:

(1) The opposite olivary body in the medulla, by the deep arcuate fibres (fig. 467, *a*).

(2) With the nuclei (nucleus gracilis and nucleus cuneatus) in which the posterior sensory tracts of the spinal cord end.

(3) With the ascending (direct) and descending cerebellar tracts, which put the cerebellum in direct communication with nerve cells in the spinal cord.

The Arrangement of the Lamellæ and Folia of the Cerebellum.—It must be confessed that at present the descriptive anatomy of the Cerebellum is largely a matter of applying names to parts the meaning of which we know little. But the present success in diagnosing and localising cerebellar disease, and the rapid strides made by physiologists in solving its function, make it important for the student to familiarise himself with its main features.

The Cerebellum is made up of two LATERAL LOBES joined together by a median part or lobe—the VERMIS or vermiform process. On the upper surface, there is no demarcation to be seen between the three lobes; but on the under surface a recess—the *vallecula*—separates the lateral lobes, and within it the middle lobe or vermis projects. The *posterior notch* also separates the lateral lobes behind, and the *anterior notch*, at which the superior peduncles issue, separates them in front.

The median section, made to expose the fourth ventricle, also shows the manner in which the folia and lamellæ are arranged in the vermiform process or middle lobe (fig. 458). In fig. 461 A, B, are shown the chief lobes on the upper and lower surfaces of the cerebellum.

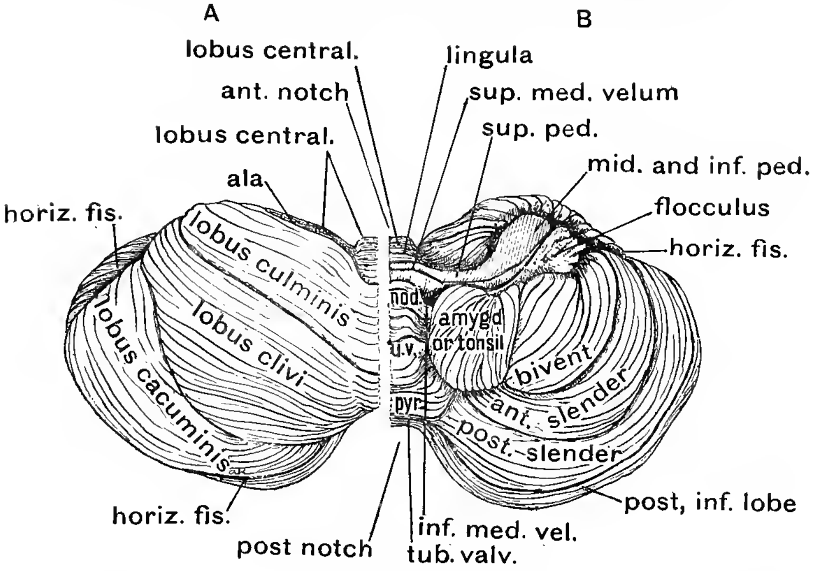
Lobes or Divisions seen on the Tentorial or Upper Surface of the Cerebellum.—(1) The LINGULA, a few bands of grey matter, has already been seen on the upper surface of the superior medullary velum (fig. 458).

(2) The LOBUS CENTRALIS (fig. 461, A) is the most anterior group of folia, attached to the central white medullary sheet (corpus trapezoides) of the cerebellum. It is best developed in

the middle lobe; it is continued on the lateral lobes as the *alæ* or *alar folia.* The lobus centralis is hid between the lingula on the superior medullary velum and the next lobe.

(3) The Lobus Culminis (fig. 461, A) consists of eight or nine lamellæ attached by a main central stem to the central medullary sheet (fig. 458). The lamellæ are subdivided into folia. The lobus culminis expands as it passes on the lateral lobes; the lateral parts are distinguished as the *anterior crescentic lobules.*

Fig. 461.—The lobes of the cerebellum. (*After Schaefer.*)
A. Those on the upper surface; B. those on the lower surface.



(4) The Lobus Clivi consists of a number of lamellæ grouped on the posterior part of the upper surface of the central medullary sheet (fig. 461, A). The lamellæ expand on the lateral lobes and form the *posterior crescentic lobules.*

(5) The Lobus Cacuminis springs from the posterior end of the central medullary sheet. In the middle lobe it is merely represented by a thin lamella—the *folium cacuminis* (fig. 458); but on the lateral lobe it expands into the *posterior superior lobules* (fig. 461, A).

The Horizontal Fissure (fig. 461, A and B) of the cerebellum separates the lamellæ arising on the upper surface of the central sheet from those on its under surface. The fissure commences in front at the exit of the middle peduncle and, sweeping round the convex margin of the cerebellum, terminates below the folium cacuminis in the posterior cerebellar notch.

Lobes on the Under Surface.—(1) The LOBUS NODULI consists of a median series of small folia, the *nodule*, projecting over the inferior medullary velum from the under surface of the middle lobe or vermiform process (fig. 458). The nodule projects into and is continuous with the inferior medullary velum (fig. 466). Through the velum it is connected on each side with the lateral part of the nodular lobe, the *flocculus*, a small grape-shaped collection of folia above the eighth nerve and behind the middle peduncle of the cerebellum. The *stalk of the flocculus* runs in the lower border of the velum (fig. 461, B).

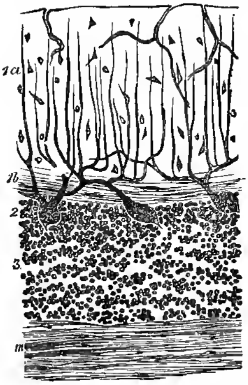
(2) The LOBUS UVULÆ (fig. 461, B) projects behind the last lobe; its main stem is subdivided into four or five lamellæ. It consists of three sharply differentiated parts: the *uvula* (fig. 458) on the under surface of the middle lobe and the *tonsils*, rounded masses of folia projecting in the anterior end of the vallecula under each lateral lobe (fig. 461, B). The uvula is connected with each tonsil by the *furrowed band*, to be seen when the uvula is pulled gently aside.

(3) The LOBUS PYRAMIDIS also consists of three parts: the *pyramid* projects from the under surface of the middle lobe, behind the uvula (fig. 458); the lateral parts are represented by the *biventral lobules*, groups of folia which project like the segment of a small orange on the outer side of the tonsil (fig. 461, B). The lateral and median parts are connected by a ridge.

(4) The LOBUS TUBERIS. The median part, the *tuber valvulæ* (fig. 458), consists of a slightly divided lamella projecting from the posterior part of the central medullary sheet. The lateral parts include the lateral folia lying between the biventral lobules in front and the great horizontal fissure behind. They can be divided into three groups or lobuli: the *anterior slender*, the *posterior slender*, and the *posterior inferior* (fig. 461, B).

The Dentate and other Nuclei within the Cerebellum.—The central sheet of white matter, so thin in the vermis or middle lobe, becomes of considerable thickness in the lateral lobes, and contains some masses of grey matter. By opening up the great horizontal fissure with the fingers, and pressing the upper lamellæ from the lower, the lateral part of the white medullary sheet will be opened and at least the *dentate nucleus* or corpus dentatum exposed. The dentate nucleus is an elongated puckered capsule of grey matter from which the superior peduncle of the cerebellum issues—forming an anterior break in it or hilum. Three small nuclei are grouped at the inner side of the hilum.

FIG. 462.—THE CONSTITUENTS OF THE CORTEX OF THE CEREBELLUM. (*Meynert.*)



1*a*. External and, 1*b*, Internal portions of the outer grey layer. 2. Layer of cells of Purkinje. 3. Inner layer. *m*. Medullary layer.

PONS VAROLII

The **Pons Varolii** joins the medulla oblongata below to the mesencephalon above. Its superficial fibres are transverse and raised markedly above the level of the medulla and mesencephalon. Laterally, they are continued into the cerebellum as the middle peduncles of that body; through the middle peduncle the nerve cells of the pons are brought into direct communication with those of the cerebellum.

The **Upper part of the Floor of the Fourth Ventricle** (figs. 459, 463) is formed by the dorsal aspect of the pons. In order to examine it the three peduncles of the cerebellum must be cut as they approach the pons and the cerebellum completely removed (fig. 459). By approximating the lateral halves of the pons, the upper triangular segment of the ventricular floor can be examined. The following points are to be noted in it:

(*a*) At its upper angle, covered by the converging superior peduncles of the cerebellum, with the superior medullary velum between them, is seen the *lower end of the aqueduct of Sylvius.*

(*b*) A *median sulcus* dividing the floor into equal right and left halves.

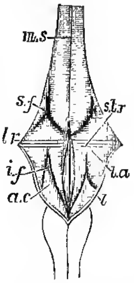
(*c*) The *fasciculus teres*, an elevation at each side of the median sulcus (fig. 460). From grey matter beneath the *eminentia teres*, an intumescence on the fasciculus teres just above the striæ acusticæ, arises the sixth nerve.

(*d*) The *striæ acusticæ* are superficial fibres which cross the floor of the ventricle at the junction of the pontine and medullary parts. These strands cross inwards from the dorsal ganglion of the auditory nerve.

(*e*) The *acoustic tubercle*, situated on each side beneath the striæ acusticæ, belongs equally to the pontine and medullary parts of the floor.

(*f*) The *fovea superior* is a slight depression above the striæ acusticæ and outside the fasciculus teres. Part of the sensory nucleus of the fifth nerve lies beneath it.

FIG. 463.—DIAGRAM OF THE FLOOR OF THE FOURTH VENTRICLE. (*Schaefer.*)



m.s. Mesial sulcus *s.f.* Superior fovea. *l.r.* Lateral recess. *str.* Striæ acusticæ. *i.f.* Inferior fovea. *t.a.* Tuberculum acusticum. *a.c.* Ala cinerea. *l.* Ligula.

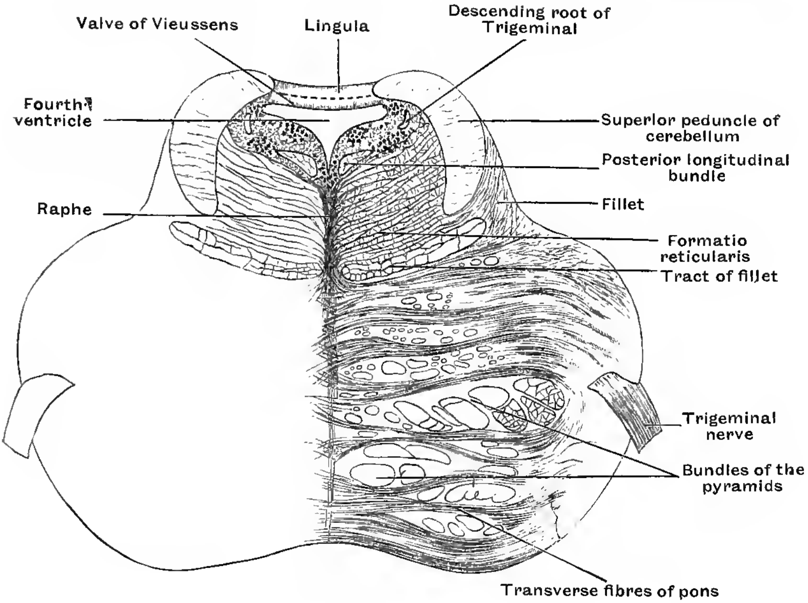
(*g*) The *locus cæruleus* is a slight depression of a black-grey tint near the upper angle, on each side; beneath it the motor nucleus of the fifth nerve is situated.

A **Transverse Section of the Pons** (fig. 464) shows, like the mesencephalon above, and the medulla below it, a division into dorsal and ventral parts. The VENTRAL PART is composed mainly of nerve fibres; many of these are transverse, being continuations of fibres of the middle peduncle of the cerebellum or of fibres arising from nuclei of the pons; others are longitudinal; the pyramidal fibres can be followed through this part of the pons to the crusta.

The dorsal part of the pons is continuous above with the tegmenta and below with the formatio reticularis of the medulla. It is made up of a mixture of nerve fibres and nerve cells (formatio reticularis). Beneath its dorsal surface, in the floor of the fourth ventricle, are situated nuclei belonging to the fifth, sixth, seventh, and eighth nerves. The posterior longitudinal bundle beneath the grey matter of the floor of the ventricle, and the fillet, lateral and mesial, ventral to the formatio reticularis, are continued upwards on each side from the medulla to the tegmentum (fig. 464).

The pons rests on the basi-sphenoid; the basilar artery sends branches to it and occupies the median groove on its basal aspect. The fifth nerve perforates the lateral part of the pons; the third pair of nerves appear at its anterior border; the sixth, seventh, and eighth, at its posterior border.

FIG. 464.—TRANSVERSE SECTION THROUGH THE UPPER PART OF THE PONS. (*Schwalbe.*)



MEDULLA OBLONGATA

The **Medulla Oblongata** is that part of the central nervous system which unites the spinal cord to the pons and cerebellum. The origin of the first cervical nerve marks the termination of the spinal cord; the origin of the hypoglossal nerve indicates the commencement of the medulla; the point of union lies between the origin of these nerves and opposite the lower border of the foramen magnum.

The OPEN AND CLOSED SEGMENTS OF THE MEDULLA.—In the lower half of the medulla, the central canal, as in the spinal cord, is covered in by an upward continuation of the posterior columns of the spinal cord; in its upper half the posterior columns are pushed aside and the canal has become dilated and opened out; the dorsal aspect of the upper half of the medulla forms the lower part of the floor of the fourth ventricle.

Medullary Part of the Floor of the Fourth Ventricle.—The following points should be recognised on this part of the dorsal aspect of the medulla oblongata (figs. 459, 463):

(*a*) The *striæ acusticæ*. They cross the acoustic tubercle and separate the upper or pontine half from the lower or medullary half of the floor.

(*b*) A *median sulcus* dividing the floor into right and left halves.

(*c*) The *inferior fovea*, a sharp triangular impression with its apex at the acoustic striæ. It divides each lateral half of the floor into three areas or *trigones*.

(*d*) The *trigonum acustici* (fig. 463), continuous with the acoustic tubercle. Beneath it is situated the dorsal nucleus of the eighth nerve.

(*e*) *Trigonum hypoglossi*; it is situated between the median sulcus and the inferior fovea. Beneath it lies the nucleus of origin of the hypoglossal nerve (fig. 467). This trigone represents a prolongation downwards of the *fasciculus teres*.

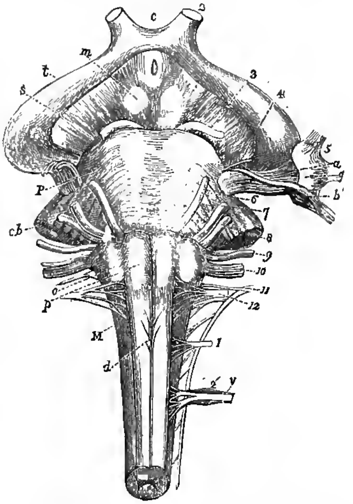
(*f*) *Trigonum vagi* is the remaining area and corresponds to the *ala cinerea* between the diverging limbs of the inferior fovea (fig. 463). The great nuclei of the vagus and glosso-pharyngeal, the cardiac and respiratory centres, are situated beneath it (fig. 459).

BOUNDARIES OF THE FLOOR OF THE FOURTH VENTRICLE (figs. 459, 466).—The floor of the fourth ventricle is diamond-shaped. Its *upper angle* is situate at the commencement of the aqueduct of Sylvius, under the apex of the superior medullary velum; its *lower angle*, the *calamus scriptorius*, lies at the opening of the central canal of the spinal cord under the obex; each *lateral angle* projects outwards behind the inferior peduncle of the cerebellum. The *upper lateral boundaries* are formed by the superior peduncles of the cerebellum. The *inferior lateral boundaries* are formed by the restiform bodies, to which the ligulæ are attached, and near the lower angle by the clavæ, to which the obex is attached (fig. 466).

Restiform Body.—The inferior peduncle of the cerebellum, when it reaches the medulla, assumes a new name—the restiform body. It appears to end in two tubercles which are situated on each side of the lower angle of the fourth ventricle. A few of its fibres do end there; a great number of them will be seen when a section is made, such as is shown in fig. 467, crossing the substance of the medulla to end in the olivary body of the opposite side. These deeply crossing strands form the *deep arcuate fibres.* The direct cerebellar (dorso-lateral ascending) and antero-lateral descending cerebellar tracts, which lie in the lateral columns of the cord, although they cannot be made out with scalpel and forceps, should be remembered as constituents of the restiform body.

The **Clavæ, Funiculus Gracilis, and Nucleus Gracilis** (fig. 466).—The postero-mesial column of the cord, a great sensory pathway, assumes the name of *funiculus gracilis* in the medulla; the fibres end in the *nucleus gracilis* (fig. 468), at the side of the lower angle of the ventricle; this nucleus causes a prominence to which the name of *clava* is given; the two clavæ bound the lower angle of the ventricle. The obex over the opening of the central spinal canal marks the point of attachment of the inferior medullary velum to the clavæ.

Fig. 465.—Front view of the upper part of the spinal cord, medulla and pons. (*Ecker.*)

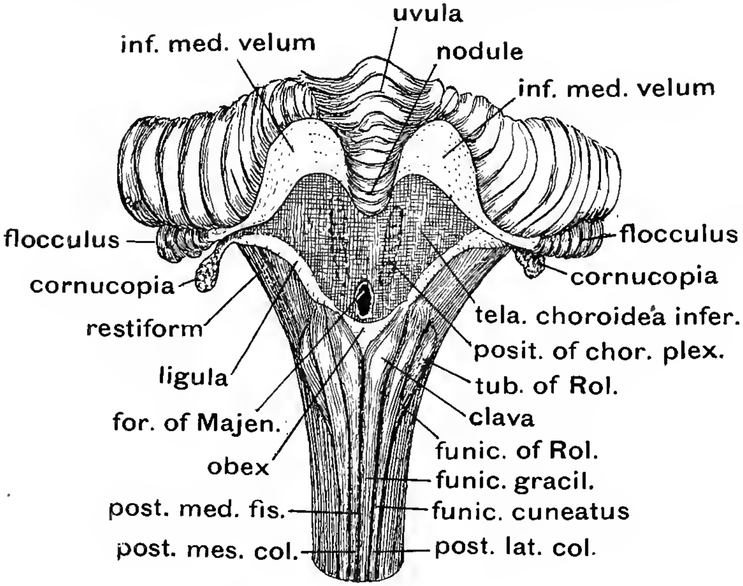


M. Medulla oblongata. *p.* Anterior pyramids. *d.* Their decussation. *o.* Olivary bodies. P. Pons Varolii. *c.b.* Peduncles of cerebellum. *s.* Crus cerebri. *m.* Corpora mammillaria. *t.* Tractus opticus. *c.* Chiasma. 2. Optic nerve. 3. Motor oculi. 4. Fourth. 5. Fifth pair. *a.* Its larger root. *b.* Its smaller root *g.* Gasserian ganglion. 6. Abducens. 7. Facial. 8. Auditory. 9. Glosso-pharyngeal. 10. Vagus. 11. Spinal accessory. 12. Hypoglossal. 1'. First spinal nerve. 2'. Second spinal nerve. *v.* Its ganglion.

The **Funiculus Cuneatus, Cuneate Nucleus, and Tubercle.** — The postero-lateral column of the spinal cord, also a sensory pathway, becomes the *cuneate funiculus* on the medulla (fig. 466). It ends in the lateral boundary of the fourth ventricle in the *cuneate nucleus*, contained in the *cuneate tubercle* (fig. 468). The cuneate tubercle (fig. 466), with the clava and restiform body, bounds the lateral ventricle.

Formation of the Fillet.—Although the sensory fibres seem to end at the cuneate and gracile nuclei, the pathway is continued upwards by the *fillet*, a band of fibres which carries the sensory impressions towards the brain. It has been seen higher up in the formatio reticularis of the pons and tegmenta of the mesencephalon (figs. 457, 464). When a section of the medulla is made near the lower angle of the fourth ventricle, the grey matter which continues upwards the posterior horn of the spinal cord is seen to be broken up by the crossing of the fibres of the fillet to the opposite side of the pons, forming the *decussatio lemnisci* (fig. 468). Thus it will be seen that sensory as well as motor pathways cross the middle line somewhere between their origin and end.

FIG. 466.—DORSAL VIEW OF THE MEDULLA WITH THE CEREBELLUM PULLED FORWARDS TO EXPOSE THE INFERIOR MEDULLARY VELUM. (*Semi-diagrammatic.*)

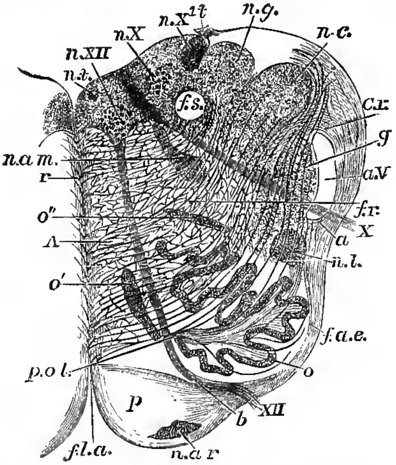


Funiculus of Rolando.—On the outer side of the funiculus cuneatus (fig. 466), a ridge, best marked in the early years of life, appears in the lower half of the medulla. To this elevation the above name has been given. It is due to the grey matter representing the posterior horn, with its surrounding gelatinous matter, being thrust towards the surface (fig. 468). The descending root of the fifth nerve lies in the funiculus (fig. 468).

The three funiculi just named (funiculus gracilis, funiculus cuneatus, and funiculus of Rolando) represent in the medulla the *posterior column* of the cord.

ANTERIOR ASPECT OF THE MEDULLA.—On its anterior or ventral aspect the medulla shows a well-marked *anterior median fissure*, continuous with the corresponding fissure of the cord (fig. 465). It ends at the lower border of the pons in a depression, the *foramen cæcum*, while in its depth, towards its lower ends, it shows the decussating fasciculi of the pyramids. The fissure contains an inflection of pia mater and numerous small spinal arteries, mostly from the anterior spinal branches of the vertebral, which dip within it and end in the substance of the medulla. The pyramids bound the fissure on each side. Outside the pyramids, on the lateral aspects of the medulla, are the olivary bodies. The roots of the hypoglossal nerves emerge between the pyramids and olivary bodies.

FIG. 467.—SECTION OF MEDULLA ABOUT THE MIDDLE OF OLIVARY BODY (*Schwalbe.*)



f.l.a. Anterior median fissure. *n.ar.* Arcuate nucleus. *p.* Pyramid. XII. Surface origin of hypoglossal, which is seen at *b*, passing between the pyramid and olive. *o.* Dentate nucleus of olive. o'. & o''. Accessory olivary nuclei. *f.a.e.* External arcuate fibres. *n.l.* Nucleus lateralis. *a.* Arcuate fibres passing towards restiform, partly through substantia gelatinosa, *g*, partly superficial to ascending root of fifth. X. Surface origin of vagus. *f.r.* Formatio reticularis. *c.r.* Restiform body. *n.c.* Nucleus cuneatus. *n.g.* Nucleus gracilis. *t.* Attachment of ligula. *f.s.* Funiculus solitarius. *n.*X. & *n.*X^1. Two nuclei of vagus. *n.*XII. Nucleus of hypoglossal. *n.t.* Nucleus of fasciculus teres. *n.am.* Nucleus ambiguus. *r.* Raphe. *A.* Anterior column of cord. *p.ol.* Peduncle of olive.

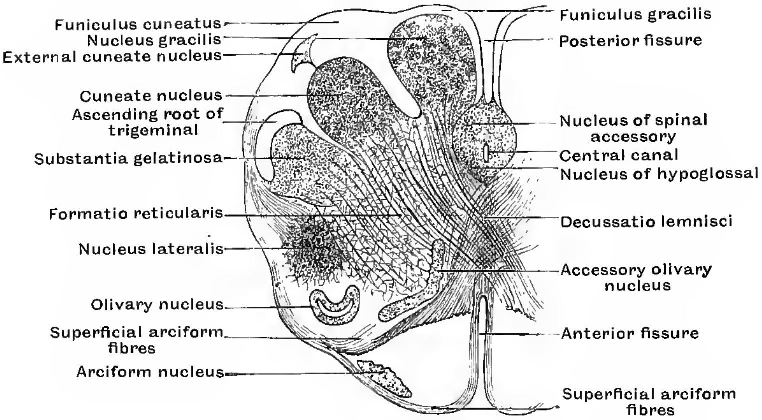
The **Pyramids** project at each side of the anterior median fissure of the medulla. They contain the motor fibres which reach this point from the cortex by the internal capsule, crusta, and pons. The direct pyramidal fibres pass into the anterior columns of the spinal cord of the same side; the *crossed pyramidal tracts*, when the anterior median fissure is opened, can be seen decussating in the lower part of the medulla. On section, the decussation can be seen to break through the continuations upwards of the anterior horns of the spinal cord. The crossed pyramidal tracts pass down the cord in the dorsal part of the lateral columns of the cord.

Thus it will be seen that both motor and sensory fibres decussate in the medulla; this decussation breaks up the cornuate arrangement of grey matter seen in the cord.

The *Hypoglossal* (XII) nerve arises at the outer border of the anterior pyramid; branches of the anterior spinal artery enter it by the *anterior median fissure.* The anterior pyramid represents, on the surface of the medulla, the anterior column of the cord.

The **Lateral Area of the Medulla.**—The pyramid represents the anterior column of the spinal cord, and the three funiculi the continuation upwards of the posterior column. The lateral tract of the medulla, between these two, represents the lateral column of the cord. The *olivary body* projects as an oval eminence from the upper half of the lateral area. The cerebellar tracts, situated in the lateral columns of the cord, pass to the restiform body in the medulla. Between the olivary and restiform bodies appear the ninth, tenth, and accessory fibres of the eleventh cranial nerves.

Fig. 468.—Transverse section of the medulla in the region of the Decussatio lemnisci. (*Schwalbe.*)



The Olivary Body in section (fig. 467) is seen to contain a puckered capsule of grey matter—the dentate nucleus. The internal arcuate fibres from the opposite inferior peduncle of the cerebellum enter at its hilum. Two accessory olivary nuclei (O′, O″, in fig. 467) lie near it.

External Arcuate or arciform fibres emerge at the anterior median fissure and outer side of the pyramid; they arch over the lower part of the olivary body to reach the restiform body (*f.a.e* in fig. 467).

Formatio Reticularis of the Medulla.—The main bulk of the medulla is made up of a reticulation of nerve fibres and cells. A raphe, made up of decussating fibres, separates the right half from the left. The fibres of the twelfth nerve divide the formatio reticularis into an outer or lateral area—the formatio grisea, and a mesial or inner area—the formatio alba (fig. 467). The nuclei belonging to the eighth, ninth, tenth, eleventh, and twelfth nerves are situated on its dorsal aspect (fig. 459). The upward continuation of the grey matter of the spinal column is spread out and broken up in the medulla, and new formations, like the olivary body and nuclei, the nucleus gracilis and nucleus cuneatus, added.

In the formatio reticularis, just dorsal to the pyramids, internal arcuate fibres concentrate to form the fillet. The posterior longitudinal bundle begins under the grey matter of the floor of the fourth ventricle, but the fibres which go to form it are derived from the formatio alba, dorsal to the pyramids, and are continuous with the *ground bundle* of the anterior column of the spinal cord.

INDEX

TO THE THIRD PART

Accessorius ad ilio-costalem, 27
Acoustic tubercle, 370
Agger nasi, 264
Alar cartilages of nose, 132
    folia, 367
    ligament, 229
Alveus, 346
Amygdaloid nucleus, 346
Angular gyrus, 330
Annulus of Vieussens, 78
Ansa cervicalis, 60
Anterior atlanto-axial ligament, 231
    cerebral artery, 308, 310
    commissure, 350
    ethmoidal artery, 262, 156
    jugular vein, 40
    nerve roots, 298
    spinal artery, 297, 312
    temporal nerve, 189
    triangle, roof of, 41
            subdivisions of, 36
Antero-lateral aspect of neck, divisions and superficial structures on, 34
    median spinal artery, 300
Antrum of Highmore, 140
Apical fibrous dome, 83
Aquæductus cochleæ, 287
    Fallopii, 272
Aqueous chamber, 171
Arachnoid, 94, 294, 304
Arcuate fibres, 373, 376
Arnold's nerve, 198, 273
Arteries. *See* special arteries
Arteries of head and neck, origin of, 84
Articular processes, 292
Arytenoid cartilages, 253
Arytenoideus, 254
Ascending cervical artery, 87
    frontal convolution, 319
            fissure, 319
            gyrus, 327
    palatine artery, 244
    parietal convolution, 319
            fissure, 319
            gyrus, 329
Ascending pharyngeal artery, 202
            tympanic branche of, 284
Asterion, 91
Atlas, anterior arch of, 227
    posterior arch of, 227
    transverse ligament of, 227, 229
Attollens auriculam, 106
Attrahens auriculam, 106
Auditory artery, 312
    nerve, 285, 314
Auricular branch of vagus nerve, 198
Auriculo-temporal nerve, 99, 178, 190 273
Axillary sheath, 44
Azygos uvulæ, 240

Back of neck, cutaneous nerves of, 4
Bartholin's duct, 213
Basal ganglia, 352, 355
Basilar artery, 311
    sinus, 118
    vein, 307
Bell, nerve of, 50
Biventer cervicis, 17
Biventral lobules, 368
Bony semicircular canals, 285
Brachial plexus, 50, 51, 53, 75
            in neck, branches of, 53
Brain, 303
    blood supply of, 306
    convolutions of, 319
    cortex of, 320
    fissures of, 320
    lower limits of, 93
    removal of, 108
    sensori-motor areas of, 318
    subarachnoid spaces at base of, 112
    sulci of, 319
    third ventricle of, 335
    veins of, 306
Bregma, 91
Buccal artery, 186

Buccinator, 131
Bulbar arteries, 312
Bulla ethmoidalis, 264
Burdach, column of, 298

Calamus scriptorius, 372
Calcarine fissure, 325
Callosal fissure, 326
  gyrus, 326
Calloso-marginal fissure, 324
Canalis reuniens, 288
Capsular ligaments of atlanto-occipital joint, 231
Carotid canal, 272
  plexus, 278
  sheath, 42
  tubercle, 83
Caruncula lachrymalis, 147
Cauda equina, 298
Caudate nucleus, 340, 353
    tail of, 346
Cavernous plexus, 124
  sinus, 117
Central artery of retina, 167
  fissure, 319
Cerebellar arteries, 312
  veins, 312
Cerebellum, 364
  horizontal fissure of, 367
  lobes on under surface of, 368
  lobes on upper surface of, 366
  nuclei within, 368
  peduncles of, 365
Cerebral veins, 306
Cerebrum, 318
Cervical and lumbar enlargements and nerve roots, position of, 299
Cervical lymphatic glands, 81
  nerves, intervertebral stages of, 223
    posterior divisions of, 22
Cervical plexus, 78
    cutaneous branches of, 38
Cervicalis ascendens, 27
Cervico-axillary passage, 50
Check ligament, 229
Chiasma, 316
Choanæ, 259
Chorda tympani, 190, 277
Choroid, 168
  plexus, 341, 346
Ciliary arteries, 155
  bodies, 168
  ganglion, 158
  muscle, 169
  erves, 157, 158
Cingulum, 338
Circular sinus, 117
Cisterna basalis, 112, 306
  pontis, 306
  Sylvii, 306
Claustrum, 355
Clavæ, 373
Cochlea, 287
  scala media of, 288
Cochleariform process, 275
Collateral fissure, 326
Common carotid artery, 62, 85
    bifurcation of, 62
Complexus, 17
  parts seen beneath, 19
Compressor nasi, 132
Conjunctiva, 165
Conus medullaris, 298
Cornea, 166
Cornucopia, 363
Corpora mammillaria, 349, 357
  quadrigemina, 361
Corpus callosum, 334, 338
  striatum, 340, 353
Corrugator supercilii, 97
Costo-cervical trunk, 90
Cranial nerves, 313
  origin of, 313
  points of exit, 122
Crico-arytenoideus lateralis, 254
    posticus, 254
Crico-thyroid membrane, 255
    muscle, 249
Cricoid cartilage, 256
Crista falciformis, 272
Cruciform ligament, 230
Crura cerebri, 357
    termination of, 335
Crusta, 357, 359
Cuneate gyrus, 331
  nucleus, 373
  tubercle, 373

Decussatio lemnisci, 374
Deep cervical artery, 19, 90
    fascia, 8, 41, 204
    glands, upper set of, 60
    lymphatic glands, 45
    vein, 19
Deep temporal arteries, 186
    nerves, 180
Dental arteries, 187
Dentate fissure, 335
  nucleus, 369
Depressor alæ nasi, 132
  anguli oris, 129
  labii inferioris, 129
Descendens hypoglossi, 60
Descending cervical nerves, 39
Digastric muscle, 204
Dilator alæ nasi, 132
Diploë, veins of, 121
Dorsal nerves, posterior divisions of, 28
  spinal plexus of veins, 33
  vessels, posterior branches of, 30
Dorsalis linguæ, 218

Ductus endolymphaticus, 287
Dura mater, 94, 114, 293

Ear, 270
  extrinsic muscles of, 105
  internal, 285
  intrinsic muscles of, 106
  vessels of, 106
Eminentia collateralis, 346
Ependyma, 339
Epicranial aponeurosis, 97
Epiglottis, 258
  attachments of, 245
Erector spinæ, 25
    tendon of, origin of, 24
Eustachian cartilage, 275
  tube, 274
    catheterisation of, 259
External auditory meatus, 272
  capsule, 355
  carotid artery, 62
    terminal part of, 177
  ear, dissection of, 104
    nerves of, 107
  jugular vein, 40
    termination of, 49
  laryngeal nerve, 65
  lateral ligament of jaw, 183
  occipital protuberance, 1, 92
  pterygoid muscle, 182
    nerve, 189
Extraspinal plexus of veins, 296
Eye, insertion of muscles to, 161
  nerve supply of, 157
  parts of, 164
Eyeball, veins of, 157
Eyelashes, 144
Eyelids, 141
  sensory nerves of, 145

Face, arteries of, 138
  dissection of, 126
  lymphatics of, 140
  sensory nerves of, 138
Facial artery, 136
    branches of, 137
    submaxillary stage of, 207
  nerve, 134, 284, 285, 315
    branches of, 135
    intra-petrous stage of, 276
    temporal branches of, 98
  vein, 138
    submaxillary stage of, 207
Fascia dentata, 334
Fasciæ. *See* special regions
Fasciculus teres, 369
Fenestra ovalis, 283
  rotunda, 283
Fifth cranial nerve, origin of, 315
    third division of, 188
Fillet, 360, 373
Filum terminale, 295, 298
First cervical spinal nerve, anterior division of, 200
  frontal gyrus, 327
  temporal gyrus, 331
Fissura choroidea, 344
Fissure of Rolando, 93
Flocculus, 368
Folium cacuminis, 367
Fontana, spaces of, 171
Foramen magnum, contents of, 113
  ovale, 283
  rotundum, 266, 283
Fornix, 143, 334
  body of, 344
Fourth cranial nerve, 150, 315
  temporal gyrus, 332
  ventricle, 361, 369
    medullary part of floor of, 372
Fovea superior, 370
Frenum linguæ, 215
Frontal artery, 96, 156
  lobe, gyri of, 327
  nerve, 150
  segments of scalp, nerves of, 98
  sinus, 109, 265
  vein, 96
Frontalis muscle, 97
Funiculus cuneatus, 373
  gracilis, 373

Gasserian ganglion, 121
Geniculate ganglion, 276
Genio-hyo-glossus muscle, 219
Genio-hyoid muscle, 216
Glands. *See* special glands
Globus pallidus, 355
Glosso-pharyngeal nerve, 197, 314
Glottis, 258
Goll, column of, 298
Great auricular nerve, 39, 139
  deep petrosal nerve, 278
  occipital nerve, 4, 103
  transverse fissure, 344
Grey matter of spinal cord, 301
Gudden's commissure, 316
Gyrus dentatus, 334
  fornicatus, 326
  lingualis, 331
  rectus, 328

Head and neck, 1
    dorsal region of 1
  surface markings of, 91
Heart, nerves for, 79
Hiatus semilunaris, 264
  vestibuli, 288

Highmore, antrum of, 264, 265
Hippocampal fissure, 335
  gyrus, 326
Hippocampus major, 345
Hyaloid membrane, 172
Hyoglossus, structures beneath, 218
  muscle, 216
Hyoid bone, 245
Hypoglossal nerve, 60, 200, 208, 313

Ilio-costalis, 27
Incisura temporalis, 332
Incus, 279
Inferior carotid triangle, 54
      triangles, contents of, 57
  cervical ganglion, 78
  dental artery, 186
    nerve, 189
  fovea, 372
  gyrus, 328
  incisive muscle, 131
  laryngeal nerves, 76
  lingualis muscle, 219
  longitudinal sinus, 116
  medullary velum, 362
  oblique, 20, 22
    origin of, 148
  palatine artery, 193, 208
  petrosal sinus, 118, 196
  thyroid artery, 58, 87
    veins, 58
  turbinate process, 266
Infra-orbital artery, 187, 267
  canal, 267
  nerve, 138
Infra-trochlear nerve, 139
Infundibulum, 264, 349
Inion, 92
Innominate artery, 84
  veins, 82
Internal auditory artery, 285
      meatus, 284
  capsule, 352
  carotid artery, 62, 124, 197, 308
      intra-petrous stage of, 278
  jugular vein, 63, 81, 195
  mammary artery, 89
  maxillary artery, 185
      branches of, 186
    vein, 188
  pterygoid muscle, 192
      nerve of, 191
  tarsal ligament, 141
Interspinous muscles, 33
Intertransverse muscles, 33, 223
Intra-parietal fissure, 330
Intraspinal plexus, 296
Intrinsic muscles of tongue, 220
Iris, 169

Jacobson's nerve, 197
Jacobson, organ of, 261
Jugular vein, 272

Lachrymal apparatus, 145
  artery, 152
  canals, 146
  gland, 146
  nerve, 98, 151
  sac, 147
Lambda, 91
Lamina cinerea, 349
  quadrigemina, 357
  spiralis, 287
Larynx, 249
  interior of, 257
  muscles of, 254
  nerves of, 251
  upper aperture of, 256
  ventricle of, 257
  vessels of, 252
Lateral cartilages of nose, 133
  hyoid point, 36
  nasal nerves, 269
  sinus, 92, 116
  ventricle, descending horn of, 345
      divisions of, 339
Left common carotid, 84
  subclavian artery, 85
Lens, 173
Lenticular ganglion, 158
  nucleus, 353, 354
Lenticulo-striate artery, 309
Levator anguli oris, 130
      scapulæ, 13
  labii superioris, 129
      alæque nasi, 129
  menti, 129
  palati, 240
  palpebræ superioris, 145, 151
Ligamenta subflava, 292
Ligaments. *See* special ligaments
Ligamentum denticulatum, 295
  nuchæ, 8
  pectinatum iridis, 171
Limbic lobe, 326
Lingual artery, 213, 216, 218
  gyrus, 332
  nerve, 190, 208
  vein, 64, 209
Lingula, 362, 363, 366
Lips, muscles of, 128
Lobus cacuminis, 367
  centralis, 366
  clivi, 367
  culminis, 367
  noduli, 368
  pyramidis, 368
  tuberis, 368
  uvulæ, 368
Locus cæruleus, 370

Long buccal nerve, 139, 188
  internal lateral ligament, 184
  thoracic nerve, 50
Longissimus dorsi, 28
Longus colli, 223
Lower lip, 126
Lumbar aponeurosis, 24
  nerves, posterior divisions of, 28
  vessels, posterior branches of, 30

Majendie, foramen of, 363
Malar nerves, 139
Malleus, 279
Marginal gyrus, 329
Masseter muscle, 179
Masseteric artery, 186
  nerve, 189
Mastication, muscles of, 178
Mastoid, antrum of, 282
  artery, 90
  processes, 2
  vein, 103
Maxillary sinus, 264, 265
Meatal artery, 186
Meatus (nasal), 264
Meckel's ganglion, 268
Medulla oblongata, 371
  anterior aspect of, 375
  formatio reticularis of, 377
  lateral area of, 376
Medullary arteries, 309
Meibomian follicles, 143
Membrana tympani, 281
Membranous labyrinth, 287
  semicircular canals, 288
Meningeal vessels, 118
Meniscus of temporo-maxillary joint, 183
Mental nerve, 139
Mesencephalon, 257
Middle cerebral artery, 308, 310
  cervical ganglion, 78
  ear, ossicles of, 279
  ethmoidal sinus, 265
  frontal gyrus, 328
  meningeal artery, 119, 186
    veins, 120
  temporal nerve, 189
  thyroid vein, 64
Monro, foramen of, 341, 350
Morgagni, sinus of, 235
Multifidus spinæ, 30
Mylo-hyoid artery, 206
  muscle, 206
  nerve, 190, 206

Nasal artery, 156
  cavities, 259
  cavity, antrum of, 263
    vestibule of, 263
Nasal duct, 147
  nerve, 139, 159, 262
Nasion, 93
Naso-labial muscle, 131
  palatine artery, 260
    nerve, 261, 269
  turbinal, 264
Neck, anterior triangle of, 34, 54
  boundaries of, 34
  divisions of, 34
  posterior triangle of, 17, 34, 47
  superficial structures of, 38
  superficial veins of, 40
  transverse section of, 3
Nerves. *See* special regions
Nose, cartilages of, 132
  lateral wall of, 262
  muscles of, 131
  roof of, 261
  septum of, 259
Nuchal furrow, 2
Nucleus gracilis, 373
Nuhn, glands of, 215

Obex, 363
Obliquus superior, 152
Occipital artery, 7, 103
    deep stage of, 90
  lobe, 331
  lymph glands, 104
  lymphatic glands, 7
  triangle, 18
  veins, 7, 103
Occipitalis, 97
  muscle, 8, 97, 104
Occipito-atlantal ligaments, 231
Ocular muscles, 161, 162
Oculo-motor nerve, 316
Odontoid process, 227
Œsophagus, cervical stage of, 58
Olfactory nerves, 316
  roots, 317
  tract, 317
  trigone, 318
Olivary body, 376
Omo-hyoid, 14, 57
Ophthalmic artery, 154, 155
  veins, 157
Optic chiasma, 349
  disc, 166
  nerves, 316
  thalamus, 341, 355
  tracts, 316, 351
Ora serrata, 168
Orbicularis oris, 131
  palpebrarum, 133
Orbit, motor nerves of, 158
  muscles surrounding, 133
  sensory nerves of, 159
Orbital muscle, 162
Otic ganglion, 191

Pacchionian bodies, 109
Palatal aponeurosis, 242
Palate, buccal surface of, 242
  vessels and nerves of, 246
Palatine artery, 188
Palato-glossus, 219, 243
  pharyngeus, 242
Palpebral arteries, 145
  membrane, 142
Paracentral lobule, 329
Para-thyroid bodies, 69
Parietal eminence, 91
  lobe, 329
Parieto-occipital fissure, 323, 325
    segments of scalp, dissection of, 103
Parotid gland, 174
    duct of, 173
  space, 173
    contents of, 176
Pars basilaris, 328
  ciliaris retinæ, 168
  intermedia, 285, 315
  orbitalis, 328
  triangularis, 328
Perforating arteries of brain, 308
Pericranium, 94
Periorbital membrane, 150, 162
Petit, canal of, 172
Petro-squamosal sinus, 117
Pharyngeal aponeurosis, 236
  fascia, 233
  plexus, 202
    veins of, 196
Pharynx, 232
  constrictors of, 234
  interior of, 236
Phrenic nerve, 74, 75
    twigs to, 53
Pia mater, 95, 294, 304
Pineal body, 350
Pituitary body, 124
Platysma myoides, 37, 128
Plicæ fimbriatæ, 215
Pneumogastric nerve, 314
Pons Varolii, 369
    transverse section of, 370
Post-central fissure, 319
    gyrus, 329
Post-parietal convolution, 330
Posterior atlanto-axial ligament, 228
  auricular artery, 178
      lymph glands, 108
      nerve, 135, 178
  axio-occipital ligament, 229
  cerebral artery, 308, 311
  common ligament, 229
  cutaneous nerves, 6
  dental artery, 267
  ethmoidal artery, 155
  ligament, 183
  longitudinal bundle, 360
Posterior nares, 259
  nerve roots, 298
  occipito-atlantal ligament, 228
  palatine artery, 243, 246
      canal, 267
      nerves, 243, 247, 269
  perforated space, 349
  root ganglia, 292
  scapular artery, 12
  spinal artery, 297, 312
  temporal nerve, 189
  triangle, roof of, 8
      subdivisions of, 37
Postero-lateral perforating arteries, 309
    spinal artery, 300
Postero-mesial perforating arteries, 310
Precentral fissure, 319
  gyrus, 327
Precuneate gyrus, 331
Prevertebral part of deep cervical fascia, 44
  region, 221
Princeps cervicis, 19, 21, 90
Promontory, 284
Pterion, 91
Pterygoid arteries, 186
  plexus of veins, 188
Pterygo-maxillary ligament, 210
Pterygo-palatine artery, 188
  canal, 267
Putamen, 355
Pyramidalis nasi, 97, 132
Pyramids, 281, 368, 375

Quadrate lobule, 331

Ramus ascendens inferior, 330
      superior, 330
  horizontalis, 330
  occipitalis, 323, 330
Rectus capitis anticus major, 222
        minor, 222
      lateralis, 223
      posticus major, 19, 22
        minor, 20, 22
  superior, 151
Recurrent laryngeal nerves, 59, 76, 251
Red nucleus, 360
Reil, island of, 321
      gyri of, 332
Restiform body, 372
Retina, 167
  central artery of, 155
Retrahens auriculam, 105
Retro-nasal fibrous hiatus, 235
Retro-pharyngeal lymph gland, 202
      part of deep cervical fascia, 44
Rhinencephalon, 327, 347

Rhomboids, 12
    nerve for, 12, 54
Right lymphatic duct, 81
Rima glottidis, 258
Risorius, 129
Rivinus, ducts of, 213
Rolando, fissure of, 319, 320
    funiculus of, 374
Rotatores dorsi, 33

SACCULE, 287
Salpingo-pharyngeus, 242
Scala tympani, 289
    vestibuli, 289
Scalenus anticus, 82
    medius, 84
    posticus, 84
Scalp, dissection of, 96
    frontal segments of, 96
    layers of, 94
    lymphatics of, 102
    nerves of, 98
    vessels of, 99
Sclerotic, 166
Second frontal gyrus, 328
    temporal gyrus, 332
Semicircular canals, 285
Semi-spinalis, 30
Septum linguæ, 220
    lucidum, 334, 341
    nasi, skeletal basis of, 261
    posticum, 295
Serratus magnus, nerve to, 53
    posticus inferior, 24
        superior, 24
Sesamoid cartilages of nose, 133
Sibson's fascia, 83
Sinus alæ parvæ, 117
    maxillaris, 140
Sixth nerve, 315
Small meningeal artery, 186
    occipital nerve, 6, 38, 103
Soft palate, 240
Sphenoidal sinus, 262
Spheno-mandibular ligament, 184
Spheno-maxillary fossa, 266
Spheno-palatine artery, 188
        foramen, 267
        ganglion, 268
            nerves of, 269
Spinal accessory nerve, 10, 61, 75, 199, 313
    arteries, 295
    canal, roof of, 291
    cord, 289
        arteries of, 296
        central canal of, 300
        position of, 298
        removal of, 113
        veins of, 297
Spinal veins, 296
Spine, muscles of, 23
Splenius, 15
    capitis, 15
    colli, 15
Stapedius muscle, 281
Stapes, 279
Stenson's duct, 173
Sterno-hyoid, 56
        layer, sheath of, 43
    mastoid, 69
        action of, 72
        blood supply of, 72
        lymphatic structures beneath, 80
        muscles beneath, 73
        nerve supply of, 71
        sheath of, 41
        space, 35, 70
            contents of, 72
Sterno-thyroid, 56
Straight sinus, 116
Striæ acusticæ, 370, 372
    longitudinales, 338
Stylo-glossus muscle, 219
    hyoid ligament, 218
        muscle, 204
    maxillary ligament, 45, 178
    pharyngeus muscle, 194
Styloid process, 178
Subapical mucous glands, 215
Subarachnoid space, contents of, 294
Subclavian artery, 49, 85
        branches of, 87
    triangle, 18, 47
        boundaries of, 47, 48
    vein, 48, 82
Subclavius, nerve to, 48, 53
Subdural space, 95, 110
Sublingual artery, 213, 218
    gland, 212
    space, 211
Submaxillary duct, 206, 207, 212
    ganglion, 208
    gland, 140, 206
        fascial capsule of, 42
    lymphatic glands, 207
    space, 205
    triangle, 203
Submental artery, 208
    gland, 140
Suboccipital muscles, action of, 22
        nerve, posterior division of, 21
        triangle, 19
            boundaries of, 19
            contents of, 21
Subparotid space, 194
Substantia nigra, 359
Sulcus choroideus, 341
Superficial cervical artery, 12
        nerve, 39

Superficial petrosal nerves, 122, 277
    temporal artery, branches of, 177
Superior carotid triangle, 59
            contents of, 60
            floor of, 67
    cerebral veins, 110
    cervical ganglion, 78, 201
    gyrus of frontal lobe, 327
    incisive muscle, 131
    intercostal artery, 90
    laryngeal nerve, 65, 199, 251
    lingual muscle, 220
    longitudinal sinus, 92, 115
    maxillary nerve, 163
            branches of, 163
    medullary velum, 362
    oblique, 20, 22
    parietal gyrus, 329
    petrosal sinus, 117
    thyroid artery, 63
        vein, 64
    turbinate process, 264
Supra-acromial nerve, 39
    clavicular triangle, 47
    hyoid artery, 218
    marginal gyrus, 329
    orbital artery, 151
        nerve, 98
    scapular artery, 14, 49, 88
        nerve, 15, 50, 53
        vein, 49
    sternal nerve, 39
    trochlear nerve, 96, 98
Suspensory ligament, 231
Sylvian point, 91
Sylvius, aqueduct of, 359
    fissure of, 321
Sympathetic system, cervical ganglia of, 77
            of neck, 65

TÆNIA hippocampi, 334
    semicircularis, 340
Tarsal plates, 142
Teeth, 247
    nerve and blood supply of, 248
Tegmentum, 357, 360
Tela choroidea inferior, 362
Temporal bone, relations of to brain, 125
    branch of temporo-malar nerve, 98
    fossa, 179
    lobe, 331
    muscle, 179
    region, superficial coverings of, 99
Temporo-facial vein, 63
Temporo-maxillary articulation, 183
            vein, 176
Tendo oculi, 141
Tenon, capsule of, 149, 152
Tenon's space, 153
Tensor palati, 242
    tarsi, 148
    tympani, 278
Tentorium cerebelli, 114
Third frontal gyrus, 328
    occipital nerve, 6
    temporal gyrus, 332
    ventricle, 348
Thoracic duct, cervical stage of, 80
Thyro-arytenoideus, 255
Thyro-hyoid, 56
        membrane, 245
        muscle, nerve to, 60
Thyroid axis, 87
    body, 67
        blood supply of, 68
        isthmus of, 67
        lateral lobes of, 68
        lymphatics of, 69
        nerves of, 69
    cartilage, 249
Thyroidea ima, 69
Tongue, 213
    nerves and vessels of, 245
    pharyngeal and buccal aspects of, 244
Tonsil, 239
Tonsillar artery, 208, 218
Torcular Herophili, 115
Trachea, cervical stage of, 58
Trachelo-mastoid, 18
Transversalis cervicis, 28
Transverse cervical artery, 50, 88
            vein, 49
    sinus, 118
Trapezial division of neck, 36
Trapezius, cervical part of 10
    sheath of, 8
Trigeminal nerve, 315
Trigonum acustici, 372
    habenulæ, 350
    hypoglossi, 372
    vagi, 372
Triradiate sulcus, 328
Trochlear nerve, 315
Tuber cinereum, 349
    valvulæ, 368
Tympanic artery, 186
    nerve, 197
    plexus of nerves, 284
Tympanum, blood supply of, 284
    cavity of, 276

UNCINATE gyrus, 326
Upper eyelid, section of, 143
Utricle, 287

VAGUS, 64
    cardiac branches of, 65, 76

Vagus, cervical stages of, 75
    nerve, 197, 273, 314
Vallecula, 366
Velum interpositum, 342, 345
Venous sinuses of skull, 115
        position of, 92
Ventricles of brain, position of, 355
Vermis of cerebellum, 366
Vertebral aponeurosis, 23
    artery, 89, 312
        stages of, 224
        suboccipital stage of, 21
    plexus of veins, 21
    triangle, 83
    veins, 226
Vesalian vein, 188
Vestibule, 285
Vicq d'Azyr, bundle of, 357
Vidian artery, 188
    canal, 267
    nerve, 269
Vieussens, valve of, 362
Vitreous humour, 172
Vocal cords, 257

WHARTON's duct, 206, 207, 212
White matter of spinal cord, 301
Willis, circle of, 308

ZONULE of Zinn, 172
Zygomatic fossa, 180
    space, contents of, 182
Zygomaticus major, 129
    minor, 129

PRINTED BY
SPOTTISWOODE AND CO. LTD., NEW-STREET SQUARE
LONDON

No. 3.

London, 7, Great Marlborough Street,
October, 1901.

A SELECTION

FROM

J. & A. CHURCHILL'S CATALOGUE,

COMPRISING

MOST OF THE RECENT WORKS PUBLISHED BY THEM.

N.B.—J. & A. Churchill's larger Catalogue, which contains over 600 works, with a Complete Index to their Subjects, will be sent on application.

Human Anatomy: A Treatise by various Authors. Edited by HENRY MORRIS, M.A., M.B. Lond., F.R.C.S., Senior Surgeon to the Middlesex Hospital. Second Edition. Roy. 8vo, with 790 Illustrations, nearly all original, and many in several colours, 36s.

Dissection Outlines for use with Morris's Anatomy. By WILLIAM A. CAMPBELL, B.S., M.D. Second Edition. 8vo, 3s.

Heath's Practical Anatomy: A Manual of Dissections. Eighth Edition. Edited by WILLIAM ANDERSON, F.R.C.S., Surgeon and Lecturer on Anatomy at St. Thomas's Hospital. Crown 8vo, with 329 Engravings, 15s.

Wilson's Anatomist's Vade-Mecum. Eleventh Edition. By HENRY E. CLARK, F.F.P.S. Glasg., Examiner in Anatomy, F.P.S. Crown 8vo, with 492 Engravings and 26 Coloured Plates, 18s.

An Atlas of Human Anatomy. By RICKMAN J. GODLEE, M.S., F.R.C.S., Surgeon and late Demonstrator of Anatomy, University College Hospital. With 48 Imp. 4to Plates (112 figures), and a volume of Explanatory Text. 8vo, £4 14s. 6d.

Human Osteology. By LUTHER HOLDEN, Consulting Surgeon to St. Bartholomew's Hospital. Eighth Edition, edited by CHARLES STEWART, F.R.S., Conservator of the Museum R.C.S., and ROBERT W. REID, M.D., F.R.C.S., Regius Professor of Anatomy in the University of Aberdeen. 8vo, with 59 Lithographic Plates and 74 Engravings. 16s.

Also.

Landmarks, Medical and Surgical. Fourth Edition. 8vo, 3s. 6d.

The Essentials of Regional Anatomy. By RICHARD J. BERRY, M.D., F.R.S., F.R.C.S. Edin., Lecturer on Anatomy in the New School of Medicine, Edinburgh. Post 8vo, interleaved, 10s. net.

A Manual of Practical Anatomy. By the late Prof. ALFRED W. HUGHES, M.B., M.C. Edin., Professor of Anatomy, King's College, London. Edited and completed by ARTHUR KEITH, M.D., Lecturer on Anatomy, London Hospital Medical College. In Three Parts, Royal 8vo. Part I., with 38 Coloured Plates and 116 Figures in the Text, 10s. 6d.

Anatomy of the Joints of Man. By HENRY MORRIS, Senior Surgeon to the Middlesex Hospital. With 44 Plates (several coloured). 8vo, 16s.

A Manual of General Pathology, for Students and Practitioners. By W. S. LAZARUS-BARLOW, B.A., M.D., Pathologist and Lecturer on Pathology, Westminster Hospital. 8vo, 21s.

Pathological Anatomy of Diseases. Arranged according to the nomenclature of the R.C.P. Lond. By NORMAN MOORE, M.D., F.R.C.P., Assistant Physician to St. Bartholomew's Hospital. Fcap. 8vo, with 111 Engravings, 8s. 6d.

A Manual of Clinical and Practical Pathology. By W. E. WYNTER, M.D., M.R.C.P., Assistant Physician to the Middlesex Hospital, and F. J. WETHERED, M.D., F.R.C.P., Assistant Physician to the Consumption Hospital, Brompton. With 4 Coloured Plates and 67 Engravings. 8vo, 12s. 6d.

General Pathology: An Introduction to. By JOHN BLAND SUTTON, F.R.C.S., Assistant Surgeon to the Middlesex Hospital. 8vo, with 149 Engravings, 14s.

The Pathologist's Handbook; A Manual of the Post-mortem Room. By T. N. KELYNACK, M.D., late Demonstrator in Morbid Anatomy, Owens College, Manchester. With 126 Illustrations, fcap. 8vo, pegamoid, 4s. 6d.

Selected Researches in Pathology. By A. G. AULD, M.D., M.R.C.P. With 14 Illustrations, 8vo, 6s.

The Human Brain: Histological and Coarse Methods of Research. By W. BEVAN LEWIS, Medical Superintendent, West Riding Asylum. 8vo, with Engravings and Photographs, 8s.

The Physiology and the Pathology of the Cerebral Circulation: an Experimental Research. By LEONARD HILL, M.B., Hunterian Professor, R.C.S. With 41 Illustrations, Royal 8vo, 12s.

Elements of Human Physiology. By ERNEST H. STARLING, M.D., F.R.C.P., F.R.S., Jodrell Professor of Physiology in University College, London. Fourth Edition, much enlarged. With 317 Engravings, 8vo, 12s. 6d.

Manual of Physiology: For Students of Medicine. By GERALD F. YEO, M.D., F.R.S. Third Edition. Crown 8vo, with 254 Engravings and Plate of Spectra, 14s.

A Class Book of Practical Physiology. By DE BURGH BIRCH, M.D., Professor of Physiology in the Yorkshire College of the Victoria University. With 62 Illustrations, crown 8vo, 6s. 6d.

Practical Lessons in Elementary Biology, for Junior Students. By PEYTON T. B. BEALE, F.R.C.S., Lecturer on Elementary Biology and Demonstrator in Physiology in King's College, London. Crown 8vo, 3s. 6d.

Medical Jurisprudence: Its Principles and Practice. By ALFRED S. TAYLOR, M.D., F.R.C.P., F.R.S. Fourth Edition, by THOMAS STEVENSON, M.D., F.R.C.P., Lecturer on Medical Jurisprudence at Guy's Hospital. 2 vols. 8vo, with 189 Engravings, 31s. 6d.

Lectures on Medical Jurisprudence and Toxicology. By FRED. J. SMITH, M.D., F.R.C.P., Lecturer on Forensic Medicine and Toxicology at the London Hospital. Crown 8vo, 7s. 6d.

Hygiene and Public Health. A Treatise by various Authors. Edited by THOMAS STEVENSON, M.D., F.R.C.P., Lecturer on Chemistry and Medical Jurisprudence at Guy's Hospital; Official Analyst to the Home Office; and SHIRLEY F. MURPHY, Medical Officer of Health of the County of London. In 3 vols., royal 8vo, fully Illustrated. Vol. I., 28s.; Vol. II., 32s.; Vol. III., 20s.

The Theory and Practice of Hygiene. (Notter & Firth.) By J. LANE NOTTER, M.D., Examiner in Hygiene and Public Health in the University of Cambridge and the English Conjoint Board, Professor of Hygiene in the Army Medical School; and W. H. HORROCKS, M.B., B.Sc., Assistant Professor of Hygiene in the Army Medical School. Second Edition. With 15 Plates and 134 other Illustrations, Royal 8vo, 25s.

A Manual of Practical Hygiene. By the late E. A. PARKES, M.D., F.R.S. Eighth Edition, by J. LANE NOTTER, A.M., M.D. 8vo, with 10 Plates and 103 Engravings, 18s.

A Handbook of Hygiene and Sanitary Science. By GEO. WILSON, M.A., M.D., LL.D., F.R.S.E., D.P.H. Camb., Medical Officer of Health for Mid-Warwickshire. Eighth Edition. Post 8vo, with Engravings, 12s. 6d.

A Simple Method of Water Analysis, especially designed for the use of Medical Officers of Health. By JOHN C. THRESH, M.D.Vic., D.Sc. Lond., D.P.H.Camb., Medical Officer of Health for the County of Essex. Third Edition. Fcap. 8vo, 2s. 6d.

Elements of Health: an Introduction to the Study of Hygiene. By LOUIS C. PARKES, M.D., D.P.H. Lond., Lecturer on Public Health at St. George's Hospital. Post 8vo, with 27 Engravings, 3s. 6d.

Diet and Food considered in relation to Strength and Power of Endurance, Training and Athletics. By ALEXANDER HAIG, M.D., F.R.C.P. Third Edition. Crown 8vo, 2s.

Effects of Borax and Boracic Acid on the Human System. By Dr. OSCAR LIEBREICH, Professor in the University of Berlin. With Plates, post 4to, 2s.

The Prevention of Epidemics and the Construction and Management of Isolation Hospitals. By ROGER MCNEILL, M.D. Edin., D.P.H. Camb., Medical Officer of Health for the County of Argyll. 8vo. With several Hospital Plans, 10s. 6d.

Hospitals and Asylums of the World; their Origin, History, Construction, Administration, Management, and Legislation. By Sir HENRY BURDETT, K.C.B. In 4 vols., with Portfolio. Complete, £12 12s. net. Vols. I. and II.—Asylums: £6 15s. net. Vols. III. and IV.—Hospitals, &c., with Portfolio of Plans, £9 net.

A Manual of Bacteriology, Clinical and Applied. With an Appendix on Bacterial Remedies, &c. By RICHARD T. HEWLETT, M.D., Professor of General Pathology and Bacteriology in King's College, London. With 75 Illustrations, post 8vo, 10s. 6d.

An Introduction to the Bacteriological Examination of Water. By W. H. HORROCKS, M.B., B.Sc., Lond., Assistant Professor of Military Hygiene in the Army Medical School, Netley; Major, Royal Army Medical Corps. With 5 Lithographic Plates, 8vo, 10s. 6d.

Mental Diseases: Clinical Lectures. By T. S. CLOUSTON, M.D., F.R.C.P. Edin., Lecturer on Mental Diseases in the University of Edinburgh. Fifth Edition. Crown 8vo, with 19 Plates, 14s.

Mental Physiology, especially in its Relation to Mental Disorders. By THEO. B. HYSLOP, M.D., Resident Physician and Medical Superintendent, Bethlem Royal Hospital; Lecturer on Mental Diseases, St. Mary's Hospital Medical School. 8vo, 18s.

The Insane and the Law: a Plain Guide for Medical Men, Solicitors, and Others as to the Detention and Treatment, Maintenance, Responsibility, and Capacity either to give evidence or make a will of Persons Mentally Afflicted. With Hints to Medical Witnesses and to Cross-Examining Counsel. By G. PITT-LEWIS, Q.C., R. PERCY SMITH, M.D., F.R.C.P., late Resident Physician, Bethlem Hospital, and J. A. HAWKE, B.A., Barrister-at-Law. 8vo, 14s.

A Dictionary of Psychological Medicine, giving the Definition, Etymology, and Synonyms of the Terms used in Medical Psychology; with the Symptoms, Treatment, and Pathology of Insanity; and THE LAW OF LUNACY IN GREAT BRITAIN AND IRELAND. Edited by D. HACK TUKE, M.D., LL.D., assisted by nearly 130 Contributors. 2 vols., 1,500 pages, royal 8vo, 42s.

The Mental Affections of Children, Idiocy, Imbecility, and Insanity. By WM. W. IRELAND, M.D. Edin., formerly Medical Superintendent of the Scottish Institution for the Education of Imbecile Children. Second Edition. With 21 Plates, 8vo, 14s.

Mental Affections of Childhood and Youth (Lettsomian Lectures for 1887, &c.). By J. LANGDON-DOWN, M.D., F.R.C.P., Consulting Physician to the London Hospital. 8vo, 6s.

The Journal of Mental Science. Published Quarterly, by Authority of the Medico-Psychological Association. 8vo, 5s.

Manual of Midwifery: Including all that is likely to be required by Students and Practitioners. By A. L. GALABIN, M.D., F.R.C.P., Obstetric Physician to Guy's Hospital. Fifth Edition. Post 8vo, with 298 Engravings, 15s.

The Practice of Midwifery: A Guide for Practitioners and Students. By D. LLOYD ROBERTS, M.D., F.R.C.P., Consulting Obstetric Physician to the Manchester Royal Infirmary, Physician to St. Mary's Hospital. Fourth Edition. Crown 8vo, with 2 Coloured Plates and 226 Woodcuts, 10s. 6d.

A Short Practice of Midwifery, embodying the Treatment adopted in the Rotunda Hospital, Dublin. By HENRY JELLETT, M.D., B.A.O. Dub., late Assistant Master, Rotunda Hospital. Third Edition. With 124 Illustrations, crown 8vo, 8s. 6d.

Obstetric Aphorisms: For the Use of Students commencing Midwifery Practice. By JOSEPH G. SWAYNE, M.D. Tenth Edition. Fcap. 8vo, with 20 Engravings, 3s. 6d.

Economics, Anæsthetics, and Antiseptics in the Practice of Midwifery. By HAYDN BROWN L.R.C.P., L.R.C.S. Fcap. 8vo, 2s. 6d.

Lectures on Obstetric Operations: A Guide to the Management of Difficult Labour. By ROBERT BARNES, M.D., F.R.C.P. Fourth Edition. 8vo, with 121 Engravings, 12s. 6d.

By the same Author.

A Clinical History of Medical and Surgical Diseases of Women. Second Edition. 8vo, with 181 Engravings, 28s.

Outlines of Gynæcological Pathology and Morbid Anatomy. By C. HUBERT ROBERTS, M.D., Lond., Physician to the Samaritan Free Hospital for Women. With 151 Illustrations, 8vo, 21s.

Manual of the Diseases peculiar to Women. By JAMES OLIVER, M.D., F.R.S. Edin., M.R.C.P. Lond., Physician to the Hospital for Diseases of Women, London. Fcap. 8vo, 3s. 6d.

By the same Author.

Abdominal Tumours and Abdominal Dropsy in Women. Crown 8vo, 7s. 6d.

The Student's Guide to the Diseases of Women. By ALFRED L. GALABIN, M.A., M.D., F.R.C.P., Obstetric Physician to Guy's Hospital. Fifth Edition. Fcap. 8vo, with 142 Engravings, 8s. 6d.

A Short Practice of Gynæcology. By HENRY JELLETT, M.D., B.A.O. Dub., late Assistant Master, Rotunda Hospital, Dublin. With 135 Illustrations, crown 8vo, 7s. 6d.

A First Series of Fifty-four Consecutive Ovariotomies, with Fifty-three Recoveries. By A. C. BUTLER-SMYTHE, F.R.C.P. Edin., Surgeon to the Samaritan Free Hospital, Senior Surgeon to the Grosvenor Hospital for Women and Children. 8vo, 6s. 6d.

Sterility. By ROBERT BELL, M.D., F.F.P. & S., Senior Physician to the Glasgow Hospital for Diseases peculiar to Women. 8vo, 5s.

Notes on Gynæcological Nursing. By JOHN BENJAMIN HELLIER, M.D., M.R.C.S., Surgeon to the Hospital for Women, &c., Leeds. Cr. 8vo, 1s. 6d.

A Manual for Hospital Nurses and others engaged in Attending on the Sick, with a Glossary. By EDWARD J. DOMVILLE, Surgeon to the Devon and Exeter Hospital. Eighth Edition. Crown 8vo, 2s. 6d.

A Short Manual for Monthly Nurses. By CHARLES J. CULLINGWORTH, M.D., F.R.C.P., Obstetric Physician to St. Thomas's Hospital. Revised by the Author with the assistance of M. A. ATKINSON, Matron of the General Lying-in Hospital, Lambeth. Fifth Edition. Fcap. 8vo, 1s. 6d.

Lectures on Medicine to Nurses. By HERBERT E. CUFF, M.D., F.R.C.S., Superintendent, North Eastern Fever Hospital, London. Third Edition. With 29 Illustrations, 3s. 6d.

Antiseptic Principles for Nurses. By C. E. RICHMOND, F.R.C.S. 8vo, 1s.

The Diseases of Children. By JAS. F. GOODHART, M.D., F.R.C.P., Consulting Physician to the Evelina Hospital for Children. Sixth Edition, with the assistance of G. F. STILL, M.D., Medical Registrar to the Gt. Ormond St. Hospital for Children. Crown 8vo, 10s. 6d.

A Practical Treatise on Disease in Children. By EUSTACE SMITH, M.D., F.R.C.P., Physician to the King of the Belgians, and to the East London Hospital for Children, &c. Second Edition. 8vo, 22s.

By the same Author.

Clinical Studies of Disease in Children. Second Edition. Post 8vo, 7s. 6d.

Also.

The Wasting Diseases of Infants and Children. Sixth (Cheap) Edition. Post 8vo, 6s.

On the Natural and Artificial Methods of Feeding Infants and Young Children. By EDMUND CAUTLEY, M.D., Physician to the Belgrave Hospital for Children. Crown 8vo, 7s. 6d.

Chloroform: A Manual for Students and Practitioners. By EDWARD LAWRIE, M.B. Edin., Lt.-Col. I.M.S., Residency Surgeon, Hyderabad. With Illustrations. Crown 4to, 5s. net.

Materia Medica, Pharmacy, Pharmacology, and Therapeutics. By W. HALE WHITE, M.D., F.R.C.P., Physician to, and Lecturer on Pharmacology and Therapeutics at, Guy's Hospital. Sixth Edition, based upon the B.P. of 1898, and on the Indian and Colonial Addendum. Fcap. 8vo, 7s. 6d.

An Introduction to the Study of Materia Medica, designed for Students of Pharmacy and Medicine. By HENRY G. GREENISH, F.I C., F L.S., Professor of Materia Medica to the Pharmaceutical Society. With 213 Illustrations. 8vo, 15s.

Materia Medica And Therapeutics. By CHARLES D. F. PHILLIPS, M.D., F.R.S. Edin.

Vegetable Kingdom — Organic Compounds—Animal Kingdom. 8vo, 25s.
Inorganic Substances. Second Edition. 8vo, 21s.

Practical Pharmacy: An Account of the Methods of Manufacturing and Dispensing Pharmaceutical Preparations; with a chapter on the Analysis of Urine. By E. W. LUCAS, F.C.S., Examiner at the Pharmaceutical Society. With 283 Illustrations. Royal 8vo, 12s. 6d.

Galenic Pharmacy: A Practical Handbook to the Processes of the British Pharmacopœia. By R. A. CRIPPS, M.P.S. 8vo, with 76 Engravings, 8s. 6d.

Practical Pharmacy. By BARNARD S. PROCTOR, formerly Lecturer on Pharmacy at the College of Medicine, Newcastle-on-Tyne. Third Edition. 8vo, with 44 Wood Engravings and 32 Lithograph Fac-Simile Prescriptions, 14s.

A Companion to the British Pharmacopœia. By PETER SQUIRE. Revised by PETER WYATT SQUIRE. Seventeenth Edition. 8vo, 12s. 6d.

By the same Authors.

The Pharmacopœias of thirty of the London Hospitals, arranged in Groups for Comparison. Seventh Edition. Fcap. 8vo, 6s.

The Galenical Preparations of the British Pharmacopœia: A Handbook for Medical and Pharmaceutical Students. By CHARLES O. HAWTHORNE, M.D., C.M., late Lecturer on Materia Medica, Queen Margaret College, Glasgow. 8vo, 4s. 6d.

The Pharmaceutical Formulary; a Synopsis of the British and Foreign Pharmacopœias. By HENRY BEASLEY. Twelfth Edition (B.P. 1898), by J. OLDHAM BRAITHWAITE. 18mo, 6s. 6d.

By the same Author.

The Druggist's General Receipt-Book. Tenth Edition. 18mo, 6s. 6d.

Also.

The Book of Prescriptions: Containing upwards of 3,000 Prescriptions from the Practice of the most eminent Physicians and Surgeons, English and Foreign. Seventh Edition. 18mo, 6s. 6d.

Selecta è Prescriptis: Containing Terms, Phrases, Contractions and Abbreviations used in Prescriptions, with Explanatory Notes, &c. Also, a Series of Abbreviated Prescriptions with Translations and Key. By J. PEREIRA, M.D., F.R.S. Eighteenth Edition, by JOSEPH INCE, F.C.S., F.L.S. 24mo, 5s.

Year-Book of Pharmacy: Containing the Transactions of the British Pharmaceutical Conference. Annually. 8vo, 10s.

Southall's Organic Materia Medica: a Handbook treating of some of the more important of the Animal and Vegetable Drugs made use of in Medicine, including the whole of those contained in the B.P. Sixth and Enlarged Edition. By JOHN BARCLAY, B.Sc. Lond. 8vo, 7s. 6d.

Manual of Botany. By J. REYNOLDS GREEN, Sc.D., M.A., F.R.S., Professor of Botany to the Pharmaceutical Society. Two Vols. Cr. 8vo.

Vol. I.—Morphology and Anatomy. Second Edition. With 778 Engravings, 7s. 6d.

,, II.—Classification and Physiology. With 417 Engravings, 10s.

By the same Author.

An Introduction to Vegetable Physiology. With 184 Illustrations, 8vo, 10s. 6d.

Medicinal Plants: Being descriptions, with original figures, of the Principal Plants employed in Medicine, and an account of their Properties and Uses. By Prof. BENTLEY and Dr. H. TRIMEN, F.R.S. In 4 vols., large 8vo, with 306 Coloured Plates, bound in Half Morocco, Gilt Edges, £11 11s.

The Student's Guide to Systematic Botany, including the Classification of Plants and Descriptive Botany. By ROBERT BENTLEY. Fcap. 8vo, with 350 Engravings, 3s. 6d.

Therapeutic Electricity and Practical Muscle Testing. By W. S. HEDLEY, M.D., in charge of the Electro-therapeutic Department of the London Hospital. With 110 Illustrations. Royal 8vo, 8s. 6d.

Practical Therapeutics: A Manual. By EDWARD J. WARING, C.I.E., M.D., F.R.C.P., and DUDLEY W. BUXTON, M.D., B.S. Lond. Fourth Edition. Crown 8vo, 14s.

By the same Author.

Bazaar Medicines of India, And Common Medical Plants: With Full Index of Diseases, indicating their Treatment by these and other Agents procurable throughout India, &c. Fifth Edition. Fcap. 8vo, 5s.

Climate and Fevers of India, with a series of Cases (Croonian Lectures, 1882). By Sir JOSEPH FAYRER, K.C.S.I., M.D. 8vo, with 17 Temperature Charts, 12s.

Psilosis or "Sprue," its Nature and Treatment; with Observations on various Forms of Diarrhœa acquired in the Tropics. By GEORGE THIN, M.D. Second and enlarged Edition, with Illustrations, 8vo, 10s.

A Manual of Family Medicine and Hygiene for India. Published under the Authority of the Government of India. By Sir WILLIAM J. MOORE, K.C.I.E., M.D., late Surgeon-General with the Government of Bombay. Sixth Edition. Post 8vo, with 71 Engravings, 12s.

By the same Author.

A Manual of the Diseases of India: With a Compendium of Diseases generally. Second Edition. Post 8vo, 10s.

The Prevention of Disease in Tropical and Sub-Tropical Campaigns. (Parkes Memorial Prize for 1886.) By Lieut.-Col. ANDREW DUNCAN, M.D., B.S. Lond., F.R.C.S., Indian Medical Service. 8vo, 12s. 6d.

A Commentary on the Diseases of India. By NORMAN CHEVERS, C.I.E., M.D., F.R.C.S., Deputy Surgeon-General H.M. Indian Army. 8vo, 24s.

Hooper's Physicians' Vade-Mecum. A Manual of the Principles and Practice of Physic. Tenth Edition. By W. A. GUY, F.R.C.P., F.R.S., and J. HARLEY, M.D., F.R.C.P. With 118 Engravings. Fcap. 8vo, 12s. 6d.

A Text-book of Medicine. By the late C. HILTON FAGGE, M.D., and P. H. PYE-SMITH, M.D., F.R.S., Consulting Physician to Guy's Hospital. Fourth Edition. 2 vols. Royal 8vo. Vol. I., cloth, 21s.

Manual of the Practice of Medicine. By FREDERICK TAYLOR, M.D., F.R.C.P., Physician to, and Lecturer on Medicine at, Guy's Hospital. Sixth Edition. 8vo, with Engravings, 16s.

The Practice of Medicine. By M. CHARTERIS, M.D., Professor of Therapeutics and Materia Medica in the University of Glasgow. Eighth Edition. Edited by F. J. CHARTERIS, M.B., Ch.B. Crown 8vo, with Engravings on Copper and Wood, 10s.

A Dictionary of Practical Medicine. By various writers. Edited by JAS. KINGSTON FOWLER, M.A., M.D., F.R.C.P., Physician to Middlesex Hospital and the Hospital for Consumption. 8vo, cloth, 21s.; half calf, 25s.

A Text-Book of Bacteriology, for Medical Students and Practitioners. By G. M. STERNBERG, M.D., Surgeon-General, U.S. Army. With 9 Plates and 200 Figures in the Text. 8vo, 24s.

How to Examine the Chest: A Practical Guide for the use of Students. By SAMUEL WEST, M.D., F.R.C.P., Assistant Physician to St. Bartholomew's Hospital. Third Edition. With 46 Engravings. Fcap. 8vo, 5s.

An Atlas of the Pathological Anatomy of the Lungs. By the late WILSON FOX, M.D., F.R.S., F.R.C.P., Physician to H.M. the Queen. With 45 Plates (mostly Coloured) and Engravings. 4to, half-bound in Calf, 70s.

By the same Author.

A Treatise on Diseases of the Lungs and Pleura. Edited by SIDNEY COUPLAND, M.D., F.R.C.P., Physician to Middlesex Hospital. Roy. 8vo, with Engravings; also Portrait and Memoir of the Author, 36s.

The Student's Guide to Diseases of the Chest. By VINCENT D. HARRIS, M.D. Lond., F.R.C.P., Physician to the City of London Hospital for Diseases of the Chest, Victoria Park. Fcap. 8vo, with 55 Illustrations (some Coloured), 7s. 6d.

Uric Acid as a Factor in the Causation of Disease. By ALEXANDER HAIG, M.D., F.R.C.P., Physician to the Metropolitan Hospital and the Royal Hospital for Children and Women. Fifth Edition. With 75 Illustrations, 8vo, 14s.

The Blood: How to Examine and Diagnose its Diseases. By ALFRED C. COLES, M.D., B.Sc. With 6 Coloured Plates. 8vo, 10s. 6d.

The Physiology of the Carbohydrates; their Application as Food and Relation to Diabetes. By F. W. PAVY, M.D., LL.D., F.R.S., F.R.C.P., Consulting Physician to Guy's Hospital. Royal 8vo, with Plates and Engravings, 10s. 6d.

Medical Lectures and Essays. By Sir G. JOHNSON, M.D., F.R.C.P., F.R.S. 8vo, with 46 Engravings, 25s.

By the same Author.

An Essay on Asphyxia (Apnœa). 8vo, 3s.

Bronchial Asthma: Its Pathology and Treatment. By J. B. BERKART, M.D., late Physician to the City of London Hospital for Diseases of the Chest. Second Edition, with 7 Plates (35 Figures). 8vo, 10s. 6d.

Also.

Ulcer of the Stomach and Duodenum. With 55 Illustrations. Royal 8vo, 10s. 6d.

Also, by Dr. SAMUEL FENWICK.

Clinical Lectures on Some Obscure Diseases of the Abdomen. Delivered at the London Hospital. 8vo, with Engravings, 7s. 6d.

Also.

The Saliva as a Test for Functional Diseases of the Liver. Crown 8vo, 2s.

The Liver. By LIONEL S. BEALE, M.B., F.R.S., Consulting Physician to King's College Hospital. With 24 Plates (85 Figures). 8vo, 5s.

By the same Author.

On Slight Ailments: And on Treating Disease. Fourth Edition. 8vo, 5s.

Text-Book of Medical Treatment (Diseases and Symptoms). By NESTOR I. C. TIRARD, M.D., F.R.C.P., Professor of the Principles and Practice of Medicine, King's College, London. 8vo, 15s.

Medical Diagnosis (Student's Guide Series). By SAMUEL FENWICK, M.D., F.R.C.P., and W. SOLTAU FENWICK, M.D., B.S. Eighth Edition. Crown 8vo, with 135 Engravings, 9s.

By the same Authors.

Outlines of Medical Treatment. Fourth Edition. Crown 8vo, with 35 Engravings, 10s.

Treatment of Some of the Forms of Valvular Disease of the Heart. By A. E. SANSOM, M.D., F.R.C.P., Physician to the London Hospital. Second Edition. Fcap. 8vo, with 26 Engravings, 4s. 6d.

The Schott Methods of the Treatment of Chronic Diseases of the Heart, with an account of the Nauheim Baths and of the Therapeutic Exercises. By W. BEZLY THORNE, M.D., M.R.C.P. Third Edition. 8vo, with Illustrations, 6s.

Guy's Hospital Reports. By the Medical and Surgical Staff. Vol. XL. Third Series. 8vo, 10s. 6d.

St. Thomas's Hospital Reports. By the Medical and Surgical Staff. Vol. XXVII. New Series. 8vo, 8s. 6d.

Medical Ophthalmoscopy: A Manual and Atlas. By SIR WILLIAM R. GOWERS, M.D., F.R.C.P., F.R.S. Third Edition. Edited with the assistance of MARCUS GUNN, M.B., F.R.C.S. With Coloured Plates and Woodcuts. 8vo, 16s.

By the same Author.

A Manual of Diseases of the Nervous System. Roy. 8vo.

Vol. I. Nerves and Spinal Cord. Third Edition by the Author and JAMES TAYLOR, M.D., F.R.C.P. With 192 Engravings, 15s.

Vol. II. Brain and Cranial Nerves: General and Functional Diseases. Second Edition. With 182 Engravings, 20s.

Also.

Clinical Lectures on Diseases of the Nervous System. 8vo, 7s. 6d.

Also.

Epilepsy and other Chronic Convulsive Diseases: their Causes, Symptoms, and Treatment. Second Edition. 8vo, 10s. 6d.

Also.

Diagnosis of Diseases of the Brain. Second Edition. 8vo, with Engravings, 7s. 6d.

Also.

Syphilis and the Nervous System. Lettsomian Lectures for 1890. 8vo, 4s.

The Nervous System, Diseases of. By J. A. ORMEROD, M.D., F.R.C.P., Physician to the National Hospital for the Paralysed and Epileptic. With 66 Illustrations. Fcap. 8vo, 8s. 6d.

Text-Book of Nervous Diseases, for Students and Practitioners of Medicine. By CHARLES L. DANA, M.D., Professor of Nervous and Mental Diseases in Bellevue Hospital Medical College, New York. Fourth Edition, with 246 Illustrations, 8vo, 20s.

Handbook of the Diseases of the Nervous System. By JAMES ROSS, M.D., F.R.C.P., Professor of Medicine in the Victoria University, and Physician to the Royal Infirmary, Manchester. Roy. 8vo, with 184 Engravings, 18s.

Diseases of the Nervous System. Lectures delivered at Guy's Hospital. By SIR SAMUEL WILKS, BART., M.D., F.R.S. Second Edition. 8vo, 18s.

Stammering: Its Causes, Treatment, and Cure. By A. G. BERNARD, M.R.C.S., L.R.C.P. Crown 8vo, 2s.

Secondary Degenerations of the Spinal Cord. By HOWARD H. TOOTH, M.D., F.R.C.P., Assistant Physician to the National Hospital for the Paralysed and Epileptic. With Plates and Engravings. 8vo, 3s. 6d.

Diseases of the Nervous System. Clinical Lectures. By THOMAS BUZZARD, M.D., F.R.C.P., Physician to the National Hospital for the Paralysed and Epileptic. With Engravings, 8vo. 15s.

By the same Author.

Some Forms of Paralysis from Peripheral Neuritis: of Gouty, Alcoholic, Diphtheritic, and other origin. Crown 8vo, 5s.

Also.

On the Simulation of Hysteria by Organic Disease of the Nervous System. Crown 8vo, 4s. 6d.

On the Typhoid Bacillus and Typhoid Fever, being the Goulstonian Lectures delivered before the Royal College of Physicians in March, 1900. By P. HORTON-SMITH, M.D., F.R.C.P. With Illustrations, 8vo, 2s 6d.

Gout in its Clinical Aspects. By J. MORTIMER GRANVILLE, M.D. Crown 8vo, 6s.

Diseases of the Liver: With and without Jaundice By GEORGE HARLEY, M.D., F.R.C.P., F.R.S. 8vo, with 2 Plates and 36 Engravings, 21s.

Rheumatic Diseases, (Differentiation in). By HUGH LANE, Surgeon to the Royal Mineral Water Hospital, Bath, and Hon. Medical Officer to the Royal United Hospital, Bath. Second Edition, much Enlarged, with 8 Plates. Crown 8vo, 3s. 6d.

Diseases of the Abdomen, Comprising those of the Stomach and other parts of the Alimentary Canal, Œsophagus, Cæcum, Intestines, and Peritoneum. By S. O. HABERSHON, M.D., F.R.C.P. Fourth Edition. 8vo, with 5 Plates, 21s.

On Gallstones, or Cholelithiasis. By E. M. BROCKBANK, M.D. Vict., M.R.C.P. Lond., Honorary Physician to the Ancoats Hospital, Manchester. Crown 8vo, 7s.

On the Relief of Excessive and Dangerous Tympanites by Puncturing the Abdomen. By JOHN W. OGLE, M.D., Consulting Physician to St. George's Hospital. 8vo, 5s. 6d.

Headaches: Their Nature, Causes, and Treatment. By W. H. DAY, M.D., Physician to the Samaritan Hospital. Fourth Edition. Crown 8vo, with Engravings, 7s. 6d.

A Handbook of Medical Climatology; embodying its Principles and Therapeutic Application, with Scientific Data of the Chief Health Resorts of the World. By S. EDWIN SOLLY, M.D., M.R.C.S., late President of the American Climatological Association. With Engravings and Coloured Plates, 8vo., 16s.

The Mineral Waters of France And its Wintering Stations (Medical Guide to). With a Special Map. By A. VINTRAS, M.D., Physician to the French Embassy, and to the French Hospital, London. Second Edition. Crown 8vo, 8s.

Illustrated Ambulance Lectures: To which is added a NURSING LECTURE. By JOHN M. H. MARTIN, M.D., F.R.C.S., Honorary Surgeon to the Blackburn Infirmary. Fourth Edition. Crown 8vo, with 60 Engravings, 2s.

Surgery: its Theory and Practice. By WILLIAM J. WALSHAM, F.R.C.S., Surgeon to, and Lecturer on Anatomy at, St. Bartholomew's Hospital. Seventh Edition. Post 8vo, with 483 Engravings, 15s.

A Synopsis of Surgery. By R. F. TOBIN, Surgeon to St. Vincent's Hospital, Dublin. Crown 8vo, interleaved, leather binding, 6s. 6d.

The Surgeon's Vade-Mecum: A Manual of Modern Surgery. By R. DRUITT, F.R.C.S. Twelfth Edition. By STANLEY BOYD, M.B., F.R.C.S. Crown 8vo, with 373 Engravings, 16s.

Operations on the Brain (A Guide to). By ALEC FRASER, Professor of Anatomy, Royal College of Surgeons in Ireland. Illustrated by 42 life-size Plates in Autotype, and 2 Woodcuts in the text. Folio, 63s.

The Operations of Surgery: Intended for Use on the Dead and Living Subject alike. By W. H. A. JACOBSON, M.A., M.B., M.Ch. Oxon., F.R.C.S., Assistant Surgeon to, and Lecturer on Anatomy at, Guy's Hospital. Third Edition. 8vo, with 401 Illustrations, 34s.

A Course of Operative Surgery. By CHRISTOPHER HEATH, Surgeon to University College Hospital. Second Edition. With 20 coloured Plates (180 figures) from Nature, by M. LÉVEILLÉ, and several Woodcuts. Large 8vo, 30s.

By the same Author.

The Student's Guide to Surgical Diagnosis. Second Edition. Fcap. 8vo, 6s. 6d.

Also.

A Manual of Minor Surgery and Bandaging. For the use of House-Surgeons, Dressers, and Junior Practitioners. Twelfth Edition, revised by BILTON POLLARD, F.R.C.S., Surgeon to University College Hospital. Fcap. 8vo, with 195 Engravings, 6s. 6d.

Also.

Injuries and Diseases of the Jaws. Fourth Edition. By HENRY PERCY DEAN, M.S., F.R.C.S., Assistant Surgeon to the London Hospital. 8vo, with 187 Wood Engravings, 14s.

Surgery. By C. W. MANSELL MOULLIN, M.A., M.D., Oxon., F.R.C.S., Surgeon and Lecturer on Physiology to the London Hospital. Large 8vo, with 497 Engravings, 34s.

The Practice of Surgery: A Manual. By THOMAS BRYANT, Consulting Surgeon to Guy's Hospital. Fourth Edition. 2 vols. crown 8vo, with 750 Engravings (many being coloured), and including 6 chromo plates, 32s.

Surgical Emergencies: Together with the Emergencies attendant on Parturition and the Treatment of Poisoning. By PAUL SWAIN, F.R.C.S., Surgeon to the South Devon and East Cornwall Hospital. Fifth Edition. Crown 8vo, with 149 Engravings, 6s.

Diseases of Bones and Joints. By CHARLES MACNAMARA, F.R.C.S., Surgeon to, and Lecturer on Surgery at, the Westminster Hospital. 8vo, with Plates and Engravings, 12s.

Abdominal Surgery. By J. GREIG SMITH, M.A., F.R.S.E. Sixth Edition. Edited by JAMES SWAIN, M.S., M.D. Lond., F.R.C.S. Eng., Assistant Surgeon to the Bristol Royal Infirmary, Professor of Surgery, University College, Bristol. Two Vols., 8vo, with 224 Engravings, 36s.

The Surgery of the Alimentary Canal. By ALFRED ERNEST MAYLARD, M.B. Lond. and B.S., Surgeon to the Victoria Infirmary, Glasgow. With 27 Swantype Plates and 89 Figures in the text, 8vo, 25s.

By the same Author.

A Student's Handbook of the Surgery of the Alimentary Canal. With 97 Illustrations. Crown 8vo, 8s. 6d.

Ovariotomy and Abdominal Surgery. By HARRISON CRIPPS, F.R.C.S., Surgical Staff, St. Bartholomew's Hospital. With numerous Plates, 8vo, 25s.

The Physiology of Death from Traumatic Fever; A Study in Abdominal Surgery. By JOHN D. MALCOLM, M.B., C.M., F.R.C.S.E., Surgeon to the Samaritan Free Hospital. 8vo, 3s. 6d.

Surgical Pathology and Morbid Anatomy. By ANTHONY A. BOWLBY, F.R.C.S., Assistant Surgeon to St. Bartholomew's Hospital. Fourth Edition. Crown 8vo, with 186 Engravings, 10s. 6d.

By the same Author.

Injuries and Diseases of Nerves and their Surgical Treatment. 8vo, with 20 Plates, 14s.

Diseases of the Thyroid Gland and their Surgical Treatment. By JAMES BERRY, B.S.Lond., F.R.C.S., Surgeon to the Royal Free Hospital and Lecturer on Surgery at the London School of Medicine for Women. With 121 Illustrations, 8vo, 14s.

Short Manual of Orthopædy. By HEATHER BIGG, F.R.C.S. Ed. Part I. Deformities and Deficiencies of the Head and Neck. 8vo, 2s. 6d.

The Human Foot: Its Form and Structure, Functions and Clothing. By THOMAS S. ELLIS, Consulting Surgeon to the Gloucester Infirmary. With 7 Plates and Engravings (50 Figures). 8vo, 7s. 6d.

Face and Foot Deformities. By FREDERICK CHURCHILL, C.M. 8vo, with Plates and Illustrations, 10s. 6d.

Royal London Ophthalmic Hospital Reports. By the Medical and Surgical Staff. Vol. XIV., Part 2. 8vo, 5s.

Ophthalmological Society of the United Kingdom. Transactions, Vol. XX. 8vo, 12s. 6d.

Manual of Ophthalmic Surgery and Medicine. By W. H. H. JESSOP, M.A., F.R.C.S., Ophthalmic Surgeon to St. Bartholomew's Hospital. With 5 Coloured Plates and 110 Woodcuts, crown 8vo, 9s. 6d.

Nettleship's Diseases of the Eye: A Manual for Students. Sixth Edition, revised and edited by W. T. HOLMES SPICER, M.B., F.R.C.S., Ophthalmic Surgeon to St. Bartholomew's Hospital and the Victoria Hospital for Children. With 161 Engravings and a Coloured Plate illustrating Colour-Blindness, crown 8vo, 8s. 6d.

Diseases and Refraction of the Eye. By N. C. MACNAMARA, F.R.C.S., Surgeon to Westminster Hospital, and GUSTAVUS HARTRIDGE, F.R.C.S., Surgeon to the Royal Westminster Ophthalmic Hospital. Fifth Edition. Crown 8vo, with Plate, 156 Engravings, also Test-types, 10s. 6d.

Diseases of the Eye: a Practical Handbook for General Practitioners and Students. By CECIL EDWARD SHAW, M.D., M.Ch., Ophthalmic Surgeon to the Ulster Hospital for Children and Women, Belfast. With a Test-Card for Colour-Blindness. Crown 8vo, 3s. 6d.

On Diseases and Injuries of the Eye: A Course of Systematic and Clinical Lectures to Students and Medical Practitioners. By J. R. WOLFE, M.D., F.R.C.S.E., Lecturer on Ophthalmic Medicine and Surgery in Anderson's College, Glasgow. With 10 Coloured Plates and 157 Wood Engravings. 8vo, £1 1s.

Normal and Pathological Histology of the Human Eye and Eyelids. By C. FRED. POLLOCK, M.D., F.R.C.S. and F.R.S.E., Surgeon for Diseases of the Eye to Anderson's College Dispensary, Glasgow. Crown 8vo, with 100 Plates (230 drawings), 15s.

Convergent Strabismus, and its Treatment; an Essay. By EDWIN HOLTHOUSE, M.A., F.R.C.S., Surgeon to the Western Ophthalmic Hospital. 8vo, 6s.

Refraction of the Eye: A Manual for Students. By GUSTAVUS HARTRIDGE, F.R.C.S., Surgeon to the Royal Westminster Ophthalmic Hospital. Eleventh Edition. Crown 8vo, with 105 Illustrations, also Test-types, &c., 6s.

By the same Author.

The Ophthalmoscope: A Manual for Students. Fourth Edition. Crown 8vo, with 65 Illustrations and 4 Plates. 4s. 6d.

Methods of Operating for Cataract and Secondary Impairments of Vision, with the results of 500 cases. By Major G. H. FINK, H.M. Indian Medical Service. Crown 8vo, with 15 Engravings, 5s.

Atlas of Ophthalmoscopy. Composed of 12 Chromo-lithographic Plates (59 Figures drawn from nature) and Explanatory Text. By RICHARD LIEBREICH, M.R.C.S. Translated by H. ROSBOROUGH SWANZY, M.B. Third Edition, 4to, 40s.

Glaucoma: Its Pathology and Treatment. By PRIESTLEY SMITH, Ophthalmic Surgeon to, and Clinical Lecturer on Ophthalmology at, the Queen's Hospital, Birmingham. 8vo, with 64 Engravings and 12 Zinco-photographs, 7s. 6d.

Eyestrain (commonly called Asthenopia). By ERNEST CLARKE, M.D., B.S Lond., Surgeon to the Central London Ophthalmic Hospital, Surgeon and Ophthalmic Surgeon to the Miller Hospital. Second Edition. 8vo, with 22 Illustrations, 5s.

Diseases and Injuries of the Ear. By Sir WILLIAM B. DALBY, F.R.C.S., M.B., Consulting Aural Surgeon to St. George's Hospital. Fourth Edition. Crown 8vo, with 8 Coloured Plates and 38 Wood Engravings. 10s. 6d.

By the same Author.

Short Contributions to Aural Surgery, between 1875 and 1896. Third Edition. 8vo, with Engravings, 5s.

Diseases of the Ear, Including the Anatomy and Physiology of the Organ, together with the Treatment of the Affections of the Nose and Pharynx, which conduce to Aural Disease. By T. MARK HOVELL, Aural Surgeon to the London Hospital, and Lecturer on Diseases of the Throat in the College. Second Edition. 8vo, with 128 Engravings, 21s.

A System of Dental Surgery. By Sir JOHN TOMES, F.R.S., and C. S. TOMES, M.A., F.R.S. Fourth Edition. Post 8vo, with 289 Engravings, 16s.

Dental Anatomy, Human and Comparative: A Manual. By CHARLES S. TOMES, M.A., F.R.S. Fifth Edition. Post 8vo, with 263 Engravings, 14s.

Dental Caries: an Investigation into its Cause and Prevention. By J. SIM WALLACE, M.D., B.Sc., L.D.S.R.C.S. 8vo, 5s.

Dental Materia Medica, Pharmacology and Therapeutics. By CHARLES W. GLASSINGTON, M.R.C.S., L.D.S. Edin.; Senior Dental Surgeon, Westminster Hospital; Dental Surgeon, National Dental Hospital; and Lecturer on Dental Materia Medica and Therapeutics to the College. Crown 8vo, 6s.

Dental Medicine: A Manual of Dental Materia Medica and Therapeutics. By FERDINAND J. S. GORGAS, M.D., D.D.S., Professor of the Principles of Dental Science in the University of Maryland. Sixth Edition. 8vo, 18s.

A Manual of Dental Metallurgy. By ERNEST A. SMITH, F.I.C., Assistant Instructor in Metallurgy, Royal College of Science, London. With 37 Illustrations. Crown 8vo, 6s. 6d.

A Practical Treatise on Mechanical Dentistry. By JOSEPH RICHARDSON, M.D., D.D.S. Seventh Edition revised and Edited by GEORGE W. WARREN, D.D.S. Roy. 8vo, with 690 Engravings, 22s.

A Manual of Nitrous Oxide Anæsthesia, for the use of Students and General Practitioners. By J. FREDERICK W. SILK, M.D. Lond., M.R.C.S., Anæsthetist to the Royal Free Hospital, Dental School of Guy's Hospital, and National Epileptic Hospital. 8vo, with 26 Engravings, 5s.

Skin Diseases of Children. By GEO. H. FOX, M.D., Clinical Professor of Diseases of the Skin, College of Physicians and Surgeons, New York. With 12 Photogravure and Chromographic Plates, and 60 Illustrations in the Text, Roy. 8vo, 12s. 6d.

A Handbook on Leprosy. By S. P. IMPEY, M.D., M.C., late Chief and Medical Superintendent, Robben Island Leper and Lunatic Asylums, Cape Colony. With 38 Plates and Map, 8vo, 12s.

Diseases of the Skin (Introduction to the Study of). By P. H. PYE-SMITH, M.D., F.R.S., F.R.C.P., Physician to, and Lecturer on Medicine in, Guy's Hospital. Crown 8vo, with 26 Engravings. 7s. 6d.

A Manual of Diseases of the Skin, with an Analysis of 20,000 consecutive Cases and a Formulary. By DUNCAN L. BULKLEY, M.D., New York. Fourth Edition, Roy. 16mo, 6s. 6d.

Cancerous Affections of the Skin. (Epithelioma and Rodent Ulcer.) By GEORGE THIN, M.D. Post 8vo, with 8 Engravings, 5s.

By the same Author.

Pathology and Treatment of Ringworm. 8vo, with 21 Engravings, 5s.

The Operative Surgery of Malignant Disease. By HENRY T. BUTLIN, F.R.C.S., Surgeon to St. Bartholomew's Hospital. Second Edition, with 12 Engravings. 8vo, 14s.

By the same Author.

Malignant Disease (Sarcoma and Carcinoma) of the Larynx. 8vo, with 5 Engravings, 5s.

Also.

Sarcoma and Carcinoma: Their Pathology, Diagnosis, and Treatment. 8vo, with 4 Plates, 8s.

Cancers and the Cancer Process: a Treatise, Practical and Theoretic. By HERBERT L. SNOW, M.D., Surgeon to the Cancer Hospital, Brompton. 8vo, with 15 Lithographic Plates. 15s.

By the same Author.

The Re-appearance (Recurrence) of Cancer after apparent Extirpation. 8vo, 5s. 6d.

Also.

The Palliative Treatment of Incurable Cancer. Crown 8vo, 2s. 6d.

Ringworm and some other Scalp Affections: their Cause and Cure. By HAYDN BROWN, L.R.C.P.Ed. 8vo, 5s.

The Diagnosis and Treatment of Syphilis. By TOM ROBINSON, M.D., Physician to the Western Skin Hospital. Second Edition, Crown 8vo, 3s. 6d.

By the same Author.

The Diagnosis and Treatment of Eczema. Second Edition, Crown 8vo, 3s. 6d.

Also.

Illustrations of Diseases of the Skin and Syphilis, with Remarks. Fasc. I. with 3 Plates. Imp. 4to, 5s.

Selected Papers on Stone, Prostate, and other Urinary Disorders. By REGINALD HARRISON, F.R.C.S., Surgeon to St. Peter's Hospital. 8vo, with 15 Illustrations. 5s.

Chemistry of Urine; A Practical Guide to the Analytical Examination of Diabetic, Albuminous, and Gouty Urine. By ALFRED H. ALLEN, F.I.C., F.C.S. With Engravings, 8vo, 7s. 6d.

Clinical Chemistry of Urine (Outlines of the). By C. A. MAC MUNN, M.A., M.D. 8vo, with 64 Engravings and Plate of Spectra, 9s.

BY SIR HENRY THOMPSON, Bart., F.R.C.S.

Diseases of the Urinary Organs. Clinical Lectures. Eighth Edition. 8vo, with 121 Engravings, 10s. 6d.

Practical Lithotomy and Lithotrity; or, An Inquiry into the Best Modes of Removing Stone from the Bladder. Third Edition. 8vo, with 87 Engravings, 10s.

The Preventive Treatment of Calculous Disease, and the Use of Solvent Remedies. Third Edition. Crown 8vo, 2s. 6d.

Tumours of the Bladder: Their Nature, Symptoms, and Surgical Treatment. 8vo, with numerous Illustrationss, 5.

Stricture of the Urethra, and Urinary Fistulæ: their Pathology and Treatment. Fourth Edition. 8vo, with 74 Engravings, 6s.

The Suprapubic Operation of Opening the Bladder for the Stone and for Tumours. 8vo, with 14 Engravings, 3s. 6d.

The Clinical Examination of Urine, with an Atlas of Urinary Deposits. By LINDLEY SCOTT, M.A., M.D. With 41 Original Plates (mostly in Colours). Crown 4to, 15s. net.

Electric Illumination of the Bladder and Urethra, as a Means of Diagnosis of Obscure Vesico-Urethral Diseases. By E. HURRY FENWICK, F.R.C.S., Surgeon to London Hospital and St. Peter's Hospital for Stone. Second Edition. 8vo, with 54 Engravings, 6s. 6d.

By the same Author.

Operative and Inoperative Tumours of the Urinary Bladder: a Clinical and Operative Study based on 500 Cases. With 39 Illustrations. 8vo, 5s.

Also.

Tumours of the Urinary Bladder. Fasc. I. Royal 8vo. 5s.

Also.

Ulceration of the Bladder, Simple, Tuberculous, and Malignant: A Clinical Study. Illustrated, 8vo, 5s.

Also.

The Cardinal Symptoms of Urinary Diseases: their Diagnostic Significance and Treatment. 8vo, with 36 Illustrations. 8s. 6d.

Atlas of Electric Cystoscopy. By Dr. EMIL BURCKHARDT, late of the Surgical Clinique of the University of Bâle, and E. HURRY FENWICK, F.R.C.S., Surgeon to the London Hospital and St. Peter's Hospital. Royal 8vo, with 34 Coloured Plates, embracing 83 Figures. 21s.

Urinary and Renal Derangements and Calculous Disorders. By LIONEL S. BEALE, F.R.C.P., F.R.S., Consulting Physician to King's College Hospital. 8vo, 5s.

Male Organs of Generation (Diseases of). By W. H. A. JACOBSON, M.Ch. Oxon., F.R.C.S., Assistant Surgeon to Guy's Hospital. 8vo, with 88 Engravings. 22s.

The Surgical Diseases of the Genito-Urinary Organs, including Syphilis. By E. L. KEYES, M.D., Professor in Bellevue Hospital Medical College, New York (a revision of VAN BUREN and KEYES' Text-book). Roy. 8vo, with 114 Engravings, 21s.

Diseases of the Rectum and Anus. By ALFRED COOPER, F.R.C.S., Senior Surgeon to the St. Mark's Hospital for Fistula; and F. SWINFORD EDWARDS, F.R.C.S., Senior Assistant Surgeon to St. Mark's Hospital. Second Edition, with Illustrations. 8vo, 12s.

Diseases of the Rectum and Anus. By HARRISON CRIPPS, F.R.C.S., Assistant Surgeon to St. Bartholomew's Hospital, &c. Second Edition. 8vo, with 13 Lithographic Plates and numerous Wood Engravings, 12s. 6d.

By the same Author.

Cancer of the Rectum. Especially considered with regard to its Surgical Treatment. Jacksonian Prize Essay. 8vo, with 13 Plates and several Wood Engravings, 6s.

Also.

The Passage of Air and Fæces from the Urethra. 8vo, 3s. 6d.

Syphilis. By ALFRED COOPER, F.R.C.S., Consulting Surgeon to the West London and the Lock Hospitals. Second Edition. Edited by EDWARD COTTERELL, F.R.C.S., Surgeon (out-patients) to the London Lock Hospital. 8vo, with 24 Full-page Plates (12 coloured), 18s.

On Maternal Syphilis, including the presence and recognition of Syphilitic Pelvic Disease in Women. By JOHN A. SHAW-MACKENZIE, M.D. 8vo, with Coloured Plates, 10s. 6d.

A Medical Vocabulary: An Explanation of all Terms and Phrases used in the various Departments of Medical Science and Practice, their Derivation, Meaning, Application, and Pronunciation. By R. G. MAYNE, M.D., LL.D. Sixth Edition by W. W. WAGSTAFFE, B.A., F.R.C.S. Crown 8vo, 10s. 6d.

A Short Dictionary of Medical Terms. Being an Abridgment of Mayne's Vocabulary. 64mo, 2s. 6d.

Dunglison's Dictionary of Medical Science: Containing a full Explanation of its various Subjects and Terms, with their Pronunciation, Accentuation, and Derivation. Twenty-second Edition, much enlarged. By RICHARD J. DUNGLISON, A.M., M.D. Super-royal 8vo, 30s.

Terminologia Medica Polyglotta: a Concise International Dictionary of Medical Terms (French, Latin, English, German, Italian, Spanish, and Russian). By THEODORE MAXWELL, M.D., B.Sc., F.R.C.S. Edin. Royal 8vo, 16s.

A German-English Dictionary of Medical Terms. By Sir FREDERICK TREVES, K.C.V.O., Surgeon to the London Hospital; and HUGO LANG, B.A. Crown 8vo, half-Persian calf, 12s.

A Handbook of Physics and Chemistry, adapted to the requirements of the first Examination of the Conjoint Board and for general use. By HERBERT E. CORBIN, B.Sc. Lond., and ARCHIBALD M. STEWART, B.Sc. Lond. With 120 Illustrations. Crown 8vo, 6s. 6d.

A Manual of Chemistry, Theoretical and Practical. By WILLIAM A. TILDEN, D.Sc., F.R.S., Professor of Chemistry in the Royal College of Science, London; Examiner in Chemistry to the Department of Science and Art. With 2 Plates and 143 Woodcuts, crown 8vo, 10s.

Chemistry, Inorganic and Organic. With Experiments. By CHARLES L. BLOXAM. Eighth Edition, by JOHN MILLAR THOMSON, F.R.S., Professor of Chemistry in King's College, London, and ARTHUR G. BLOXAM, Head of the Chemistry Department, The Goldsmiths' Institute, New Cross. 8vo, with nearly 300 Illustrations, 18s. 6d.

By the same Author.

Laboratory Teaching; Or, Progressive Exercises in Practical Chemistry. Sixth Edition. By ARTHUR G. BLOXAM. Crown 8vo, with 80 Engravings, 6s. 6d.

Watts' Organic Chemistry. Edited by WILLIAM A. TILDEN, D.Sc., F.R.S., Professor of Chemistry, Royal College of Science, London. Second Edition. Crown 8vo, with Engravings, 10s.

Practical Chemistry And Qualitative Analysis. By FRANK CLOWES, D.Sc. Lond., Emeritus Professor of Chemistry in the University College, Nottingham. Seventh Edition. Post 8vo, with 101 Engravings and Frontispiece, 8s. 6d.

Quantitative Analysis. By FRANK CLOWES, D.Sc. Lond., Emeritus Professor of Chemistry in the University College, Nottingham, and J. BERNARD COLEMAN, Assoc. R. C. Sci. Dublin; Professor of Chemistry, South-West London Polytechnic. Fifth Edition. Post 8vo, with 122 Engravings, 10s.

By the same Authors.

Elementary Quantitative Analysis. Post 8vo, with 62 Engravings, 4s. 6d.

Also.

Elementary Practical Chemistry and Qualitative Analysis. Third Edition. Post 8vo, with 68 Engravings, 3s. 6d.

Qualitative Analysis. By R. FRESENIUS. Translated by CHARLES E. GROVES, F.R.S. Tenth Edition. 8vo, with Coloured Plate of Spectra and 46 Engravings, 15s.

By the same Author.

Quantitative Analysis. Seventh Edition.

Vol. I., Translated by A. VACHER. 8vo, with 106 Engravings, 15s.

Vol. II., Translated by C. E. GROVES, F.R.S. 8vo, with 143 Engravings, 20s.

Inorganic Chemistry. By Sir EDWARD FRANKLAND, K.C.B., D.C.L., LL.D., F.R.S., and FRANCIS R. JAPP, M.A., Ph.D., F.I.C., F.R.S., Professor of Chemistry in the University of Aberdeen. 8vo, with numerous Illustrations on Stone and Wood, 24s.

Inorganic Chemistry (A System of). By WILLIAM RAMSAY, Ph.D., F.R.S., Professor of Chemistry in University College, London. 8vo, with Engravings, 15s.

By the same Author.

Elementary Systematic Chemistry for the Use of Schools and Colleges. With Engravings. Crown 8vo, 4s. 6d.; Interleaved, 5s. 6d.

Valentin's Practical Chemistry and Qualitative and Quantitative Analysis. Edited by W. R. HODGKINSON, Ph.D., F.R.S.E., Professor of Chemistry and Physics in the Royal Military Academy, and Artillery College, Woolwich. Ninth Edition. 8vo, with Engravings and Map of Spectra, 9s. [The Tables separately, 2s. 6d.]

Practical Chemistry, Part I. Qualitative Exercises and Analytical Tables for Students. By J. CAMPBELL BROWN, Professor of Chemistry in Victoria University and University College, Liverpool. Fourth Edition. 8vo, 2s. 6d.

The Analyst's Laboratory Companion: a Collection of Tables and Data for Chemists and Students. By ALFRED E. JOHNSON, A.R.C.S.I., F.I.C. Second Edition, enlarged, crown 8vo., cloth, 5s., leather, 6s. 6d.

Volumetric Analysis: Or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases. By FRANCIS SUTTON, F.C.S., F.I.C. Eighth Edition. 8vo, with 116 Engravings, 20s.

Commercial Organic Analysis: a Treatise on the Properties, Modes of Assaying, Proximate Analytical Examination, &c., of the various Organic Chemicals and Products employed in the Arts, Manufactures, Medicine, &c. By ALFRED H. ALLEN, F.I.C., F.C.S. 8vo.

Vol. I.—Introduction, Alcohols, Neutral Alcoholic Derivatives, &c., Ethers, Vegetable Acids, Starch and its Isomers, Sugars, &c. Third Edition. 18s.

Vol. II.—Part I. Fixed Oils and Fats, Glycerin, Nitro-Glycerin, Dynamites and Smokeless Powders, Wool-Fats, Dégras, etc. Third Edition. 14s.

Vol. II.—Part II. Hydrocarbons, Petroleum and Coal-Tar Products, Asphalt, Phenols and Creosotes, &c. Third Edition. 14s.

Vol. II.—Part III. Terpenes, Essential Oils, Resins and Camphors, Acid Derivatives of Phenols, Aromatic Acids. [*In preparation.*

Vol. III.—Part I. Tannins, Dyes and Colouring Matters, Inks. Third Edition. 18s.

Vol. III.—Part II. The Amines and Ammonium Bases, Hydrazines and Derivatives, Bases from Tar, The Antipyretics, &c., Vegetable Alkaloids, Tea, Coffee, Cocoa, Kola, Cocaine, Opium, &c. Second Edition. 18s.

Vol. III.—Part III. Vegetable Alkaloids, Non-Basic Vegetable Bitter Principles, Animal Bases, Animal Acids, Cyanogen and its Derivatives, &c. Second Edition. 16s.

Vol. IV.—The Proteïds and Albuminous Principles, Proteoïds or Albuminoïds. Second Edition. 18s.

Cooley's Cyclopædia of Practical Receipts, and Collateral Information in the Arts, Manufactures, Professions, and Trades: Including Medicine, Pharmacy, Hygiene and Domestic Economy. Seventh Edition, by W. NORTH, M.A. Camb., F.C.S. 2 Vols., Roy. 8vo, with 371 Engravings, 42s.

Chemical Technology: A Manual. By RUDOLF VON WAGNER. Translated and Edited by SIR WILLIAM CROOKES, F.R.S., from the Thirteenth Enlarged German Edition as remodelled by Dr. FERDINAND FISCHER. 8vo, with 596 Engravings, 32s.

Chemical Technology; Or, Chemistry in its Applications to Arts and Manufactures. Edited by CHARLES E. GROVES, F.R.S., and WILLIAM THORP, B.Sc.

Vol. I.—FUEL AND ITS APPLICATIONS. By E. J. MILLS, D.Sc., F.R.S., and F. J. ROWAN, C.E. Royal 8vo, with 606 Engravings, 30s.

Vol. II.—LIGHTING BY CANDLES AND OIL. By W. Y. DENT, J. McARTHUR, L. FIELD and F. A. FIELD, BOVERTON REDWOOD, and D. A. LOUIS. Royal 8vo, with 358 Engravings and Map, 20s.

Vol. III.—GAS LIGHTING. By CHARLES HUNT. With 2 Plates and 292 Engravings. Royal 8vo, 18s.

Technological Handbooks. EDITED BY JOHN GARDNER, F.I.C., F.C.S., and JAMES CAMERON, F.I.C.

BREWING, DISTILLING, AND WINE MANUFACTURE. Crown 8vo, with Engravings, 6s. 6d.

OILS, RESINS, AND VARNISHES. Crown 8vo, with Engravings. 7s. 6d.

SOAPS AND CANDLES. Crown 8vo, with 54 Engravings, 7s.

Chemistry an Exact Mechanical Philosophy. By FRED. G. EDWARDS. Illustrated. 8vo, 3s. 6d.

The Microscope and its Revelations. By the late WILLIAM B. CARPENTER, C.B., M.D., LL.D., F.R.S. Eighth Edition, by the Rev. W. H. DALLINGER, LL.D., F.R.S. With 23 Plates and more than 800 Wood Engravings. 8vo, 28s. Half Calf, 32s.

Methods and Formulæ Used in the Preparation of Animal and Vegetable Tissues for Microscopical Examination, including the Staining of Bacteria. By PETER WYATT SQUIRE, F.L.S. Crown 8vo, 3s. 6d.

The Quarterly Journal of Microscopical Science. Edited by E. RAY LANKESTER, M.A., LL.D., F.R.S.; with the co-operation of ADAM SEDGWICK, M.A., F.R.S., W. F. R. WELDON, M.A., F.R.S., and SYDNEY J. HICKSON, M.A., F.R.S. Each Number, 10s.

The Microtomist's Vade-Mecum: A Handbook of the Methods of Microscopic Anatomy. By ARTHUR BOLLES LEE, Assistant in the Russian Laboratory of Zoology at Villefranche-sur-Mer (Nice). Fifth Edition. 8vo, 15s.

Photo-Micrography (Guide to the Science of). By EDWARD C. BOUSFIELD, L.R.C.P. Lond. 8vo, with 34 Engravings and Frontispiece, 6s.

A Treatise on Physics. By ANDREW GRAY, LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow. Vol. I. Dynamics and Properties of Matter. With 350 Illustrations. 8vo, 15s.

An Introduction to Physical Measurements, with Appendices on Absolute Electrical Measurements, &c. By Dr. F. KOHLRAUSCH, Professor at the University of Strassburg. Third English Edition, by T. H. WALLER, B.A., B.Sc., and H. R. PROCTER, F.I.C., F.C.S. 8vo, with 91 Illustrations, 12s. 6d.

Tuson's Veterinary Pharmacopœia, including the Outlines of Materia Medica and Therapeutics. Fifth Edition. Edited by JAMES BAYNE, F.C.S., Professor of Chemistry and Toxicology in the Royal Veterinary College. Crown 8vo, 7s. 6d.

The Veterinarian's Pocket Remembrancer: being Concise Directions for the Treatment of Urgent or Rare Cases. By GEORGE ARMATAGE, M.R.C.V.S. Second Edition. Post 8vo, 3s.

Chauveau's Comparative Anatomy of the Domesticated Animals, revised and enlarged, with the Cooperation of S. ARLOING, Director of the Lyons Veterinary School. Edited by GEO. FLEMING, C.B., LL.D., F.R.C.V.S., late Principal Veterinary Surgeon of the British Army. Second English Edition. 8vo, with 585 Engravings, 31s. 6d.

Human Nature, its Principles and the Principles of Physiognomy. By PHYSICIST. Part I., Imp. 16mo, 2s. Part II. (completing the work), 2s. 6d.

Encyclopædia Medica, under the general editorship of CHALMERS WATSON, M.B., M.R.C.P.E. About 12 Volumes, 20s. each net. Vols. I. to VIII. now ready.

INDEX TO J. & A. CHURCHILL'S LIST.

Allen's Chemistry of Urine, 11
——— Commercial Organic Analysis, 13
Armatage's Veterinary Pocket Remembrancer, 14
Auld's Pathol. Researches, 2
Barnes (R.) on Obstetric Operations, 3
——— on Diseases of Women, 3
Beale (L. S.) on Liver, 6
——— Slight Ailments, 6
——— Urinary and Renal Derangements, 12
Beale (P. T. B.) on Elementary Biology, 2
Beasley's Book of Prescriptions, 5
——— Druggists' General Receipt Book, 5
——— Pharmaceutical Formulary, 5
Bell on Sterility, 4
Bentley and Trimen's Medicinal Plants, 5
Bentley's Systematic Botany, 5
Berkart's Bronchial Asthma, 6
Bernard on Stammering, 7
Berry's (Jas.) Thyroid Gland, 9
——— (R. J.) Regional Anatomy, 1
Bigg's Short Manual of Orthopædy, 9
Birch's Practical Physiology, 2
Bloxam's Chemistry, 12
——— Laboratory Teaching, 12
Bousfield's Photo-Micrography, 14
Bowlby's Injuries and Diseases of Nerves, 9
——— Surgical Pathology and Morbid Anatomy, 9
Brockbank on Gallstones, 8
Brown's (Haydn) Midwifery, 3
——— Ringworm, 11
——— (Campbell) Practical Chemistry, 13
Bryant's Practice of Surgery, 8
Bulkley on Skin Diseases, 10
Burckhardt's (E.) and Fenwick's (E. H.) Atlas o Cystoscopy, 11
Burdett's Hospitals and Asylums of the World, 2
Butler-Smythe's Ovariotomies, 4
Butlin's Operative Surgery of Malignant Disease, 11
——— Malignant Disease of the Larynx, 11
——— Sarcoma and Carcinoma, 11
Buzzard's Diseases of the Nervous System, 7
——— Peripheral Neuritis, 7
——— Simulation of Hysteria, 7
Cameron's Oils, Resins, and Varnishes, 14
——— Soaps and Candles, 14
Campbell's Dissection Outlines, 1
Carpenter and Dallinger on the Microscope, 14
Cautley's Infant Feeding, 4
Charteris' Practice of Medicine, 6
Chauveau's Comparative Anatomy, 14
Chevers' Diseases of India, 5
Churchill's Face and Foot Deformities, 9
Clarke's Eyestrain, 10
Clouston's Lectures on Mental Diseases, 3
Clowes and Coleman's Quantitative Analysis, 13
——— Elmntry Practical Chemistry, 13
Clowes' Practical Chemistry, 13
Coles on Blood, 6
Cooley's Cyclopædia of Practical Receipts, 14
Cooper on Syphilis, 12
Cooper and Edwards' Diseases of the Rectum, 12
Corbin and Stewart's Physics and Chemistry, 12
Cripps' (H.) Ovariotomy and Abdominal Surgery, 9
——— Cancer of the Rectum, 12
——— Diseases of the Rectum and Anus, 12
——— Air and Fæces in Urethra, 12
Cripps' (R. A.) Galenic Pharmacy, 4
Cuff's Lectures to Nurses, 4
Cullingworth's Short Manual for Monthly Nurses, 4
Dalby's Diseases and Injuries of the Ear, 10
——— Short Contributions, 10
Dana on Nervous Diseases, 7
Day on Headaches, 8
Domville's Manual for Nurses, 4
Druitt's Surgeon's Vade-Mecum, 8
Duncan (A.), on Prevention of Disease in Tropics, 5
Dunglison's Dictionary of Medical Science, 12
Edwards' Chemistry, 14
Ellis's (T. S.) Human Foot, 9
Encyclopædia Medica, 14
Fagge's Principles and Practice of Medicine, 6
Fayrer's Climate and Fevers of India, 5
Fenwick (E. H.), Electric Illumination of Bladder, 11
——— Tumours of Urinary Bladder, 11
——— Ulceration of Bladder, 11
Fenwick (E. H.), Symptoms of Urinary Diseases, 11
Fenwick's (S.) Medical Diagnosis, 6
——— Obscure Diseases of the Abdomen, 6
——— Outlines of Medical Treatment, 6
——— Ulcer of the Stomach and Duodenum, 6
——— The Saliva as a Test, 6
Fink's Operating for Cataract, 9
Fowler's Dictionary of Practical Medicine, 6
Fox (G. H.) on Skin Diseases of Children, 10
Fox (Wilson), Atlas of Pathological Anatomy of Lungs, 6
——— Treatise on Diseases of the Lungs, 6
Frankland and Japp's Inorganic Chemistry, 13
Fraser's Operations on the Brain, 8
Fresenius' Qualitative Analysis, 13
——— Quantitative Analysis, 13
Galabin's Diseases of Women, 3
——— Manual of Midwifery, 3
Gardner's Brewing, Distilling, and Wine Manuf., 14
Glassington's Dental Materia Medica, 10
Godlee's Atlas of Human Anatomy, 1
Goodhart's Diseases of Children, 4
Gorgas' Dental Medicine, 10
Gowers' Diagnosis of Diseases of the Brain, 7
——— Manual of Diseases of Nervous System, 7
——— Clinical Lectures, 7
——— Epilepsy, 7
——— Medical Ophthalmoscopy, 7
——— Syphilis and the Nervous System, 7
Granville on Gout, 7
Gray's Treatise on Physics, 14
Green's Manual of Botany, 5
——— Vegetable Physiology, 5
Greenish's Materia Medica, 4
Groves' and Thorp's Chemical Technology, 14
Guy's Hospital Reports, 7
Habershon's Diseases of the Abdomen, 7
Haig's Uric Acid, 6
——— Diet and Food, 2
Harley on Diseases of the Liver, 7
Harris's (V. D.) Diseases of Chest, 6
Harrison's Urinary Organs, 11
Hartridge's Refraction of the Eye, 9
——— Ophthalmoscope, 9
Hawthorne's Galenical Preparations of B.P., 5
Heath's Injuries and Diseases of the Jaws, 8
——— Minor Surgery and Bandaging, 8
——— Operative Surgery, 8
——— Practical Anatomy, 1
——— Surgical Diagnosis, 8
Hedley's Therapeutic Electricity, 5
Hellier's Notes on Gynæcological Nursing, 4
Hewlett's Bacteriology, 3
Hill on Cerebral Circulation, 2
Holden's Human Osteology, 1
——— Landmarks, 1
Holthouse on Strabismus, 9
Hooper's Physicians' Vade-Mecum, 5
Horrock's Bacteriological Examination of Water, 3
Horton-Smith on Typhoid, 7
Hovell's Diseases of the Ear, 10
Hughes and Keith's Practical Anatomy, 1
Human Nature and Physiognomy, 14
Hyslop's Mental Physiology, 3
Impey on Leprosy, 10
Ireland on Mental Affections of Children, 3
Jacobson's Male Organs of Generation, 12
——— Operations of Surgery, 8
Jellett's Practice of Midwifery, 3
——— Gynæcology, 3
Jessop's Ophthalmic Surgery and Medicine, 9
Johnson's (Sir G.) Asphyxia, 6
——— Medical Lectures and Essays, 6
——— (A. E.) Analyst's Companion, 13
Journal of Mental Science, 3
Kelynack's Pathologist's Handbook, 1
Keyes' Genito-Urinary Organs and Syphilis, 12
Kohlrausch's Physical Measurements, 14
Lancereaux's Atlas of Pathological Anatomy, 2
Lane's Rheumatic Diseases, 7
Langdon-Down's Mental Affections of Childhood, 3
Lawrie on Chloroform, 4
Lazarus-Barlow's General Pathology, 1
Lee's Microtomist's Vade Mecum, 14
Lewis (Bevan) on the Human Brain, 2
Liebreich (O.) on Borax and Boracic Acid, 2

[*Continued on the next page.*

LONDON: 7, GREAT MARLBOROUGH STREET.

Liebreich's (R). Atlas of Ophthalmoscopy, 10
Lucas's Practical Pharmacy, 4
MacMunn's Clinical Chemistry of Urine, 11
Macnamara's Diseases and Refraction of the Eye, 9
Macnamara's Diseases of Bones and Joints, 8
McNeill's Epidemics and Isolation Hospitals, 2
Malcolm's Physiology of Death, 9
Martin's Ambulance Lectures, 8
Maxwell's Terminologia Medica Polyglotta, 12
Maylard's Surgery of Alimentary Canal, 9
Mayne's Medical Vocabulary, 12
Microscopical Journal, 14
Mills and Rowan's Fuel and its Applications, 14
Moore's (N.) Pathological Anatomy of Diseases, 1
Moore's (Sir W. J.) Family Medicine for India, 5
——— Manual of the Diseases of India, 5
Morris's Human Anatomy, 1
——— Anatomy of Joints, 1
Moullin's (Mansell) Surgery, 8
Nettleship's Diseases of the Eye, 9
Notter's Hygiene, 2
Ogle on Tympanites, 8
Oliver's Abdominal Tumours, 3
———Diseases of Women, 3
Ophthalmic (Royal London) Hospital Reports, 9
Ophthalmological Society's Transactions, 9
Ormerod's Diseases of the Nervous System, 7
Parkes' (E.A.) Practical Hygiene, 2
Parkes' (L.C.) Elements of Health, 2
Pavy's Carbohydrates, 6
Pereira's Selecta è Prescriptis, 5
Phillips' Materia Medica and Therapeutics, 4
Pitt-Lewis's Insane and the Law, 3
Pollock's Histology of the Eye and Eyelids, 9
Proctor's Practical Pharmacy, 4
Pye-Smith's Diseases of the Skin, 10
Ramsay's Elementary Systematic Chemistry, 13
———Inorganic Chemistry, 13
Richardson's Mechanical Dentistry, 10
Richmond's Antiseptic Principles for Nurses, 4
Roberts' (C. H.) Gynæcological Pathology, 3
Roberts' (D. Lloyd) Practice of Midwifery, 3
Robinson's (Tom) Eczema, 11
——— Illustrations of Skin Diseases, 11
——— Syphilis, 11
Ross's Diseases of the Nervous System, 7
St. Thomas's Hospital Reports, 7
Sansom's Valvular Disease of the Heart, 7
Scott's Atlas of Urinary Deposits, 11
Shaw's Diseases of the Eye, 9
Shaw-Mackenzie on Maternal Syphilis, 12
Short Dictionary of Medical Terms, 12
Silk's Manual of Nitrous Oxide, 10
Smith's (Ernest A.) Dental Metallurgy, 10
Smith's (Eustace) Clinical Studies, 4
———Disease in Children, 4
———Wasting Diseases of Infants and Children, 4
Smith's (F. J.) Medical Jurisprudence, 2
Smith's (J. Greig) Abdominal Surgery, 8
Smith's (Priestley) Glaucoma, 10
Snow's Cancer and the Cancer Process, 11
——— Palliative Treatment of Cancer, 11
——— Reappearance of Cancer, 11
Solly's Medical Climatology, 8
Southall's Materia Medica, 5
Squire's (P.) Companion to the Pharmacopœia, 4
——— London Hospitals Pharmacopœias, 4
——— Methods and Formulæ, 14
Starling's Elements of Human Physiology, 2
Sternberg's Bacteriology, 6
Stevenson and Murphy's Hygiene, 2
Sutton's (J. B.), General Pathology, 1
Sutton's (F.) Volumetric Analysis, 13
Swain's Surgical Emergencies, 8
Swayne's Obstetric Aphorisms, 3
Taylor's (A. S.) Medical Jurisprudence, 2
Taylor's (F.) Practice of Medicine, 6
Thin's Cancerous Affections of the Skin, 10
———Pathology and Treatment of Ringworm, 10
——— on Psilosis or "Sprue," 5
Thompson's (Sir H.) Calculous Disease, 11
——— Diseases of the Urinary Organs, 11
——— Lithotomy and Lithotrity, 11
——— Stricture of the Urethra, 11
——— Suprapubic Operation, 11
——— Tumours of the Bladder, 11
Thorne's Diseases of the Heart, 7
Thresh's Water Analysis, 2
Tilden's Manual of Chemistry, 12
Tirard's Medical Treatment, 6
Tobin's Surgery, 8
Tomes' (C. S.) Dental Anatomy, 10
Tomes' (J. and C. S.) Dental Surgery, 10
Tooth's Spinal Cord, 7
Treves and Lang's German-English Dictionary, 12
Tuke's Dictionary of Psychological Medicine, 3
Tuson's Veterinary Pharmacopœia, 14
Valentin and Hodgkinson's Practical Chemistry, 13
Vintras on the Mineral Waters, &c., of France, 8
Wagner's Chemical Technology, 14
Wallace on Dental Caries, 10
Walsham's Surgery: its Theory and Practice,
Waring's Indian Bazaar Medicines, 5
——— Practical Therapeutics, 5
Watts' Organic Chemistry, 12
West's (S.) How to Examine the Chest, 6
White's (Hale) Materia Medica, Pharmacy, &c., 4
Wilks' Diseases of the Nervous System, 7
Wilson's (Sir E.) Anatomists' Vade-Mecum, 1
Wilson's (G.) Handbook of Hygiene, 2
Wolfe's Diseases and Injuries of the Eye, 9
Wynter and Wethered's Practical Pathology, 1
Year-Book of Pharmacy, 5
Yeo's (G. F.) Manual of Physiology, 2

N.B.—J. & A. Churchill's larger Catalogue of about 600 *works on Anatomy, Physiology, Hygiene, Midwifery, Materia Medica, Medicine, Surgery, Chemistry, Botany, &c. &c., with a complete Index to their Subjects, for easy reference, will be forwarded post free on application.*

AMERICA.—*J. & A. Churchill being in constant communication with various publishing houses in America are able to conduct negotiations favourable to English Authors.*

LONDON: 7, *GREAT MARLBOROUGH STREET.*